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TABULATED CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES  
PRODUCED BY 61-MeV PROTONS ON  $^{58}\text{Fe}$

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ABSTRACT

Tabulated differential cross sections are presented for the production of proton, deuteron, triton, helium-3, and alpha particles from  $^{56}\text{Fe}$  bombarded by approximately 61-MeV protons. Continuum cross sections are listed at 10 angles from 20 deg through 160 deg. Angular distributions are given for excitation of states at 0-, 0.85-, 2.66-, 3.11-, 4.55-, 5.26-, and 6.79-MeV in  $^{56}\text{Fe}$ ; 0-, 0.41-, 0.93-, 1.92-, 2.99-, 4.97-, and 7.86-MeV in  $^{55}\text{Fe}$ ; and the ground state in  $^{54}\text{Fe}$ .

The differential cross sections for the production of proton, deuteron, triton, helium-3 and alpha particles produced by bombardment of  $^{56}\text{Fe}$  by  $\sim 61$ -MeV protons were measured over a secondary energy range from  $\sim 4$  to 61 MeV. This report gives the tabulated cross sections for the secondary charged particles while the details of the experimental system and data analysis are reported elsewhere.<sup>1</sup>

Approximately 61-MeV protons were accelerated by the Oak Ridge Isochronous Cyclotron, momentum analyzed in a 153-deg magnet, and focused on the target in a spot of approximately 8-mm diameter. The reaction particles from the target were detected in an all solid-state three-counter (in several runs a two-detector telescope was used — see Table 1) telescope utilizing lithium-drifted germanium as the total absorption detector.<sup>2</sup> The overall energy resolution of the data reported here was approximately 180 to 200 keV (FWHM). The secondary particle type was

determined by the  $\Delta E$  versus  $E$  method, which permitted unambiguous identification over an energy range from a few MeV to 61 MeV. Data were obtained from three ADC's for each event, processed in an on-line PDP-8 computer, and written on magnetic tape. The data were analyzed on the ORNL IBM-360 and CDC 1604 computers and on the PDP-8.

The  $^{56}\text{Fe}$  target was fabricated by the Isotopes Division at the Oak Ridge National Laboratory and had thickness and uniformity as shown on Table 2 along with other experimental parameters and the assigned systematic uncertainties. The target thickness did not affect the low-energy cutoff of any of the data presented here. Rather the cutoff energies in Table 1 were limited by the experimental system, which did not provide any time-of-flight information. In the case of the data for runs denoted in Table 3 by run numbers between 1126 and 1140, the cutoff energy was determined by the use of only one  $\Delta E$  detector instead of the usual two. In general, the data published here are from the early experimental runs. A list of the factors by which counts are multiplied to give millibarns (steradian) $^{-1}$  are given for each angle in Table 3.

The  $^{56}\text{Fe}$  data have been corrected for the effects of: nuclear reactions in the germanium detector, dead layer in the path of the scattered particles, multiple scattering of the secondary protons by the  $\Delta E$  detectors, and energy loss from the scattered particles in the target. These corrections are described in reference 1. Collimator misalignment and penetration corrections were unnecessary because an anticoincidence collimator was employed.

For the runs in the "3000" series, the uncorrected multiple scattering effect near 12 MeV for deuterons and near 15 MeV for tritons led

Table 1. Low-Energy Cutoffs  
 $^{56}\text{Fe}$ 

Particle Type	Low-Energy Cutoff	Reason
Proton	8.5 or 3.8 MeV	Use of 1 or 2 $\Delta E$ detectors and no time of flight
Deuteron	11.6 or 4.8 MeV	"
Triton	13.4 or 5.9 MeV	"
Helium-3	12.9 MeV	No time of flight data
Alpha	14.3 MeV	"

Table 2. Experimental Parameters and Uncertainties<sup>a</sup>

Targets	
<sup>56</sup> Fe: Thickness	4.16 ± 0.083 mg/cm <sup>2</sup>
Nonuniformity	± 1%
Isotopic purity	99.7%
Beam Energies	
1000 runs	60.49 ± 0.1 MeV
3000 runs	61.48 ± 0.1 MeV
4000 runs	61.25 ± 0.1 Me
Collimator	
Area (cm <sup>2</sup> )	0.353 ± 1.5%
Distance (cm)	47.0 ± 1%
Material	NE-102 scintillator
Thickness	0.1 cm
Detector Angle	± 0.5 deg.
Zero Angle	± 0.5 deg.
Angular Resolution	± 1.2 deg.
Target Angle	± 0.5 deg.
Beam Spot Diameter	0.8 cm
Beam Spot Walk	± 0.4 cm
Collimator Misalignment at Chamber Center	± 0.5 cm
Uncertainty in Dead Time Measurement	± 1%
Uncertainty in Number of Protons Striking Target	± 1%
Uncertainty induced by the excess tail	± 5% <sup>b</sup>
Combined Absolute Uncertainty	± 8% (9% for 20 & 90 degs)

a) Estimated 2/3 confidence intervals.

b) This contribution is absent at particle energies below ~ 40 MeV



Table 3.  $^{56}\text{Fe}$  - 61-MeV Incident Protons

Lab Angle (deg)	Run Number	Factor <sup>a</sup>
15	1131	2.157(-3) <sup>b</sup>
20	1130	5.271(-4)
22	3012	2.983(-4)
25	1132	2.294(-4)
30	1127	2.855(-4)
37	3010	2.185(-4)
45	1126	1.842(-4)
52	3011	1.091(-4)
60	1133	1.325(-4)
75	3007	9.530(-5)
90	1134	1.172(-4)
120	1140	4.615(-5)
135	4013	9.631(-5)

a) numbers by which the counts are multiplied to give millibarns/steradian

b) read as  $2.157 \times 10^{-3}$

to nonphysical discontinuities in the output spectra. We interpret that most events were counted, but that some events which should have appeared in the few MeV region just above the discontinuity were recorded instead at energies just below the discontinuity. The data taken in this "3000" series of runs also suffered from quite poor peak shape for monoenergetic input; this peak shape affected the accuracy of separation of neighboring peaks.

The analysis system included the standard correction for nuclear reactions in the germanium detector, but there is strong evidence that in the experiments which yielded this data an additional similar correction is required. An experiment was performed during the "1000" series of runs with the detector system in a very weak 60 MeV proton beam. Indeed, the tail beneath the peak contained about 6% of the peak intensity (at small angles a much larger fraction of the continuum intensity) beyond that accounted for by our standard corrections. This effect most likely originated in multiple scattering of protons out of the sensitive part of a misaligned germanium detector, and therefore falls off rapidly with angle as driven by the elastic scattering. (For 60 MeV protons the path length through the germanium is about 1 cm.) With this data and interpretation, it was necessary to correct the continuum spectra at 20, 30, and 37 deg in the 30-60 MeV region for the effect of this 6% extra tail. An additional uncertainty of  $\frac{1}{2}$  the correction was applied at 20 and 30 deg and one equal to the correction at 37 deg (since that data was obtained in the 3000 series). The magnitude of this uncertainty precluded publication of the proton continuum spectra at 15 and 22 deg. It was also necessary at the highest energies to multiply the observed number of counts by  $1.06 \pm .06$ , and

this was done for the tables of proton elastic and inelastic scattering. Since the correction should behave like the square of the incident particle energy, no extra multiplicative correction was applied to the cross sections for (p,d) reactions or to the continuum cross sections, though 6% was added to the overall uncertainty because of the excess tail. The absolute uncertainty in the other corrections totals about 1%, and is included in the combined value shown in Table 2.

It was not possible to reanalyze the 20-, 25-, and 90-degree data with the latest program refinements. The combined uncertainty on the data from these angles is taken as 9%.

The proton, deuteron, and triton spectra from  $^{56}\text{Fe}$  show, at most angles, the presence of many high energy peaks, most of which are cleanly separated from surrounding peaks so that cross sections may be obtained. Figures 1 and 2 show the first few MeV of excitation for the proton and deuteron spectra at 30 deg. Differential cross sections were extracted for the following levels (marked with an arrow in Figs. 1 and 2) in the  $^{56}\text{Fe}$  nucleus: 0, 0.85, 2.66, 3.11, 4.55, 5.26, and 6.79 MeV. These cross sections are listed in Tables 4-10. The cross sections for the 0.85-MeV level show uncertainties which reflect the difficulty in stripping this peak from the neighboring elastic peak. Several other peaks were observed in the proton spectra; however, these appeared to originate from excitation of more than one level. In many cases, in order to obtain the peak cross section, an apparent continuum (presumably consisting of many weakly excited, unresolved levels) which was assumed to be smoothly varying was subtracted from the data. For example, in figure 1, a smooth continuum, with magnitude varying from  $\sim 2$  to 1 mb/sr/MeV, was subtracted from the

data in order to obtain the peak cross sections between 6 and 9 MeV of excitation. The uncertainties shown on all tables should be used in combination with the combined overall uncertainty (7-9%) shown in Table 2. Differential cross sections for the excitation of the ground state ( $Q = -8.98$  MeV), 0.41-, 0.93-, 1.42-, 2.99-, 4.97-, and 7.86-MeV states in  $^{56}\text{Fe}$  were obtained from the  $^{56}\text{Fe}(p,d)^{55}\text{Fe}$  reaction and are listed in Tables 11-17. The triton spectra showed excitation of several states in  $^{54}\text{Fe}$  via the  $^{56}\text{Fe}(p,t)^{54}\text{Fe}$  reaction, however, the statistics were too poor to permit extraction of differential cross sections for any level other than the ground state reaction ( $Q = -12.02$  MeV). The cross sections for this level are listed in Table 18. The excitation energies given for the levels listed are those obtained in the experiment and are uncertain by  $\pm 0.02$  MeV. The low-lying levels are consistent with the literature.

Figures 3-7 show the angle integrated proton, deuteron, triton, helium-3, and alpha spectra from  $^{56}\text{Fe}$ . The broad peaks at the high energy end of some of the figures are generated by discrete peaks in the data which are kinematically smeared out in the integral over angle. The proton angle integral does not include the elastic scattering and the low-energy cutoff for each plot is that given in Table 21.

Table 19 is a list of the binned cross sections integrated over angle for each particle type, for  $^{56}\text{Fe}$ , in units of millibarns/MeV; the energy listed is for the lower edge of each bin. Table 20 shows the energy integrated cross sections at each angle in units of millibarns/steradian, for 61-MeV protons on  $^{56}\text{Fe}$ . This table also lists the low-energy cutoff for each particle type at each angle. The total cross sections, in millibarns, for the production of proton, deuteron, triton, helium-3 and

alpha particles from  $^{56}\text{Fe}$  are listed in Table 21 along with low-energy cutoffs for the data. The secondary proton cross sections listed do not include the elastic scattering cross section, while the cross sections for the other secondary particles include all observed events.

Tables 22-26 list, for each angle, cross sections for proton, deuteron, triton, helium-3, and alpha production from  $^{56}\text{Fe}$ , binned in 0.4-MeV wide bins at low energies and 1-MeV wide bins elsewhere, in units of millibarns ( $\text{steradian}^{-1}, \text{MeV}^{-1}$ ). The bin energies listed are for the center of the bins. Cross sections are listed for energies above the cutoffs discussed in Table 20.

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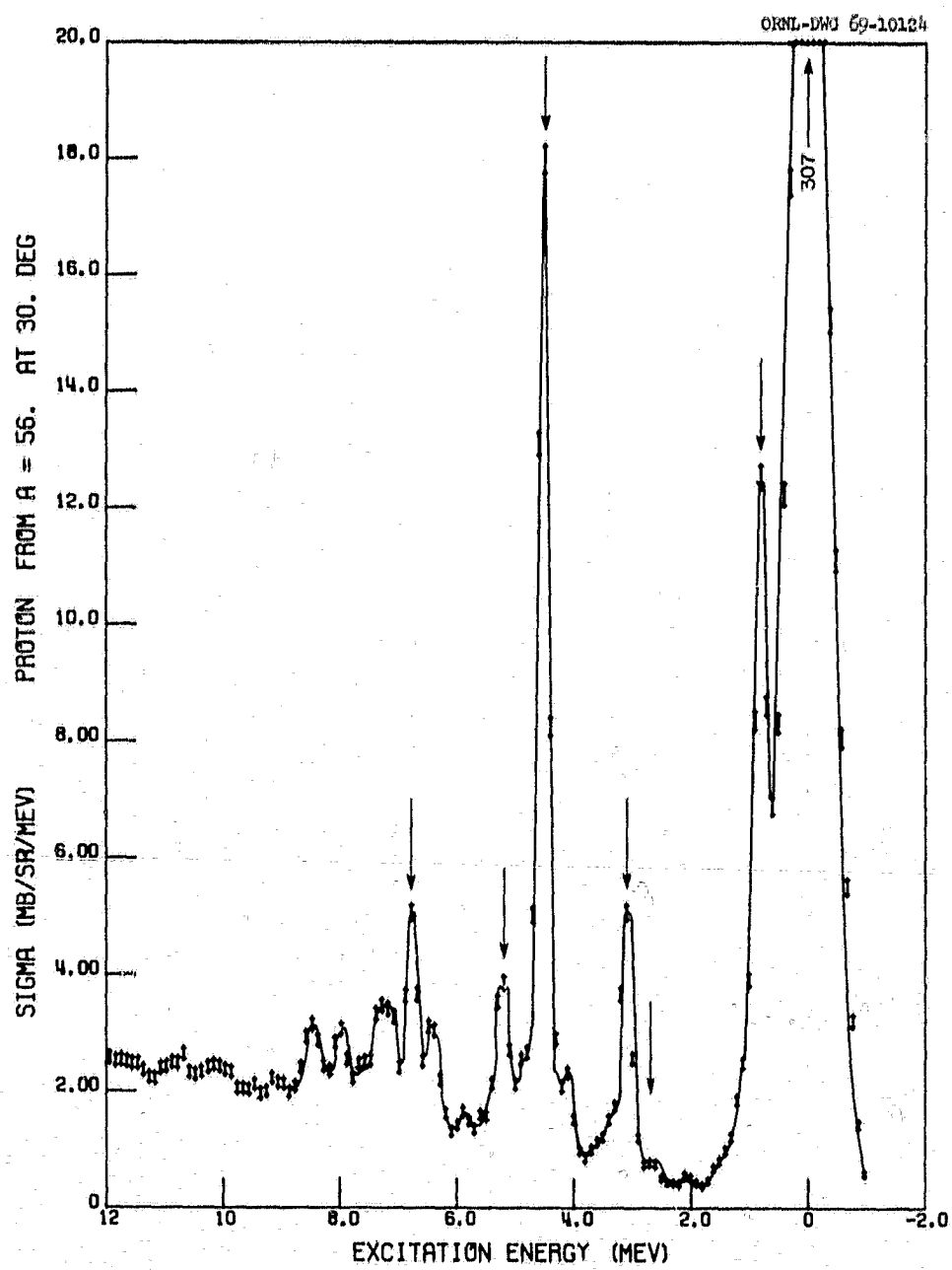


Fig. 1. High-energy Proton Pulse Height Spectrum from  $^{56}\text{Fe}$  at 30 degrees

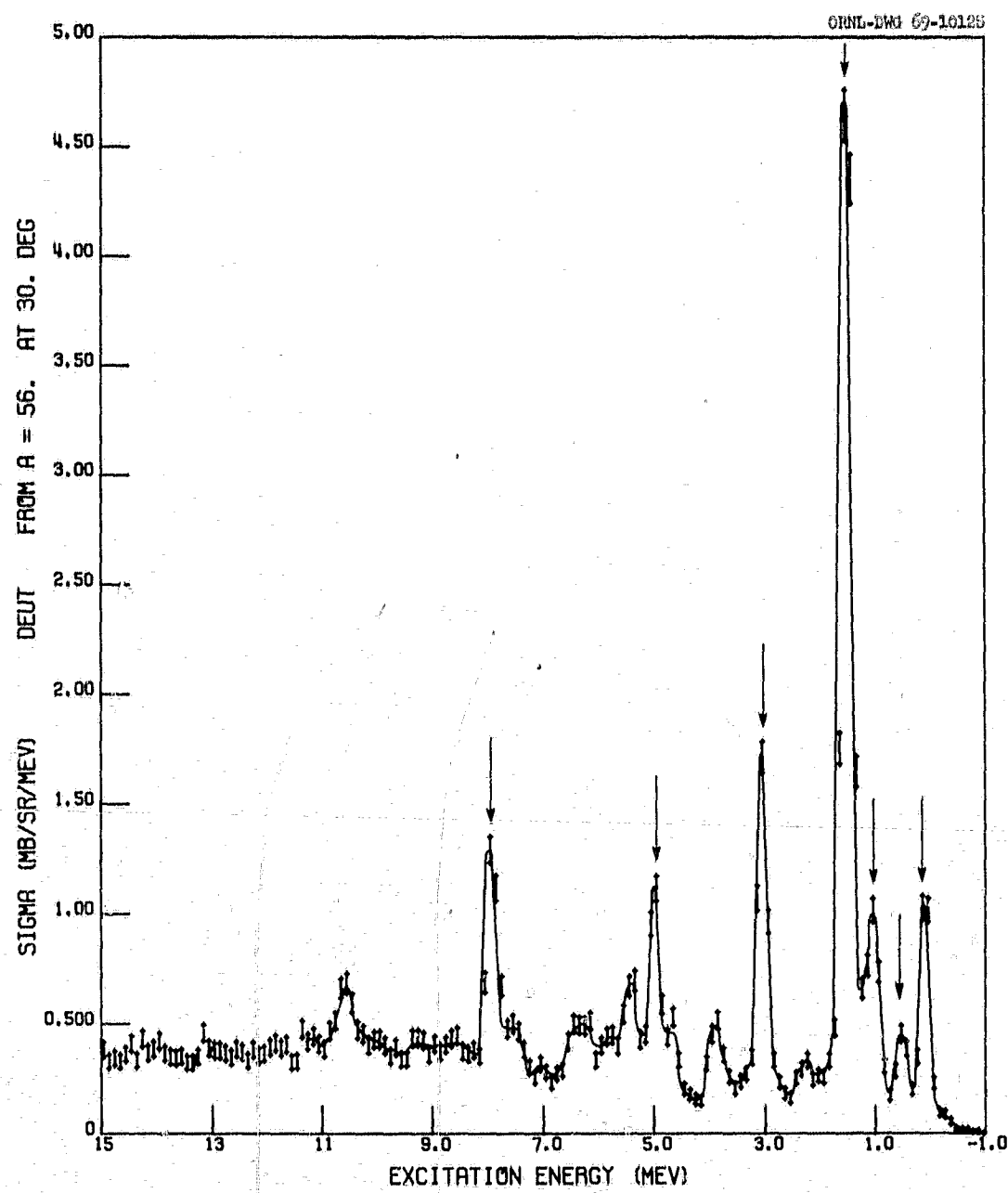


Fig. 2. High-energy Deuteron Pulse Height Spectrum from  $^{56}\text{Fe}$  at 30 degrees

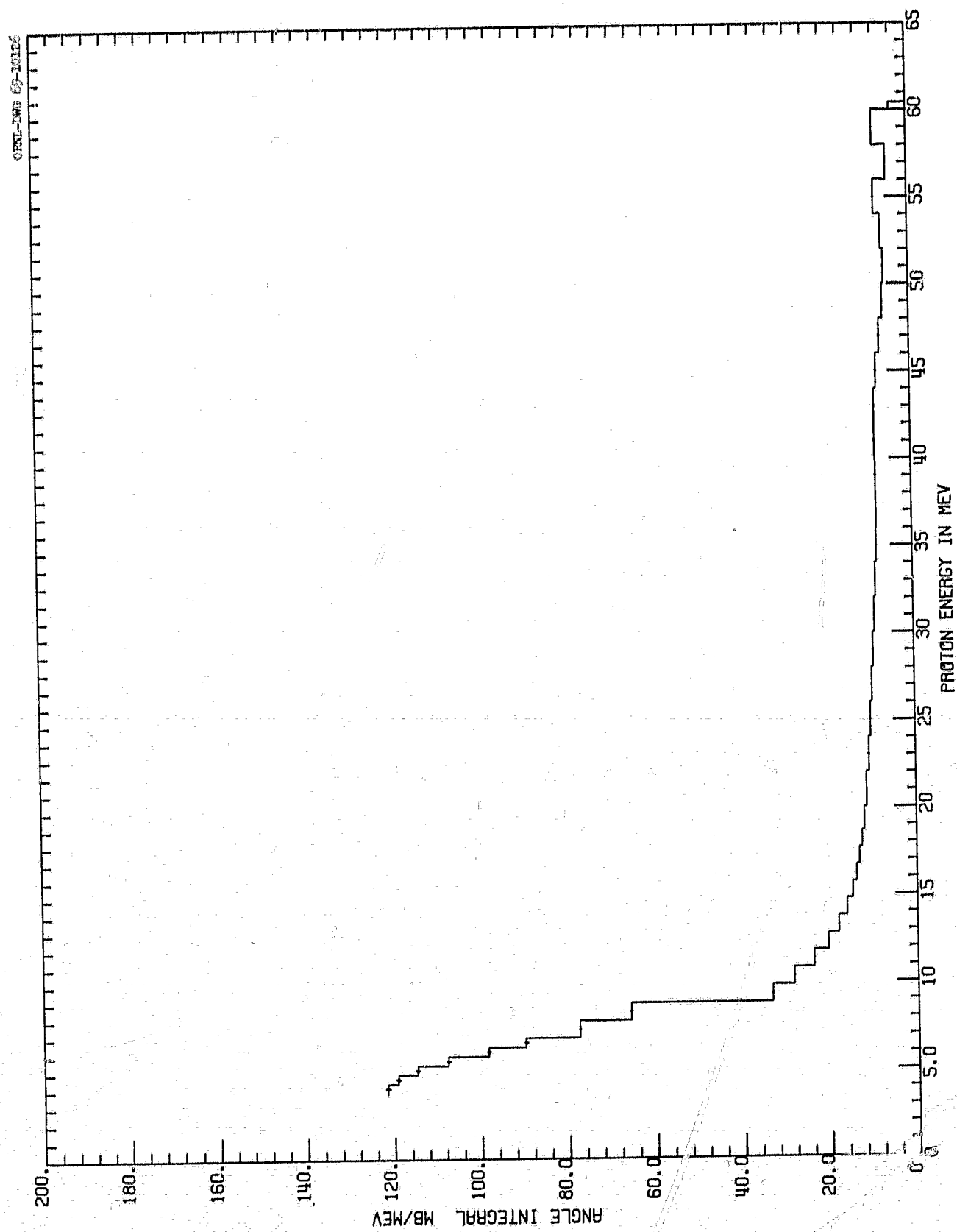


Fig. 3. Angle-integrated Proton Spectrum from  $^{56}\text{Fe}$   
(Elastic scattering is not included.)

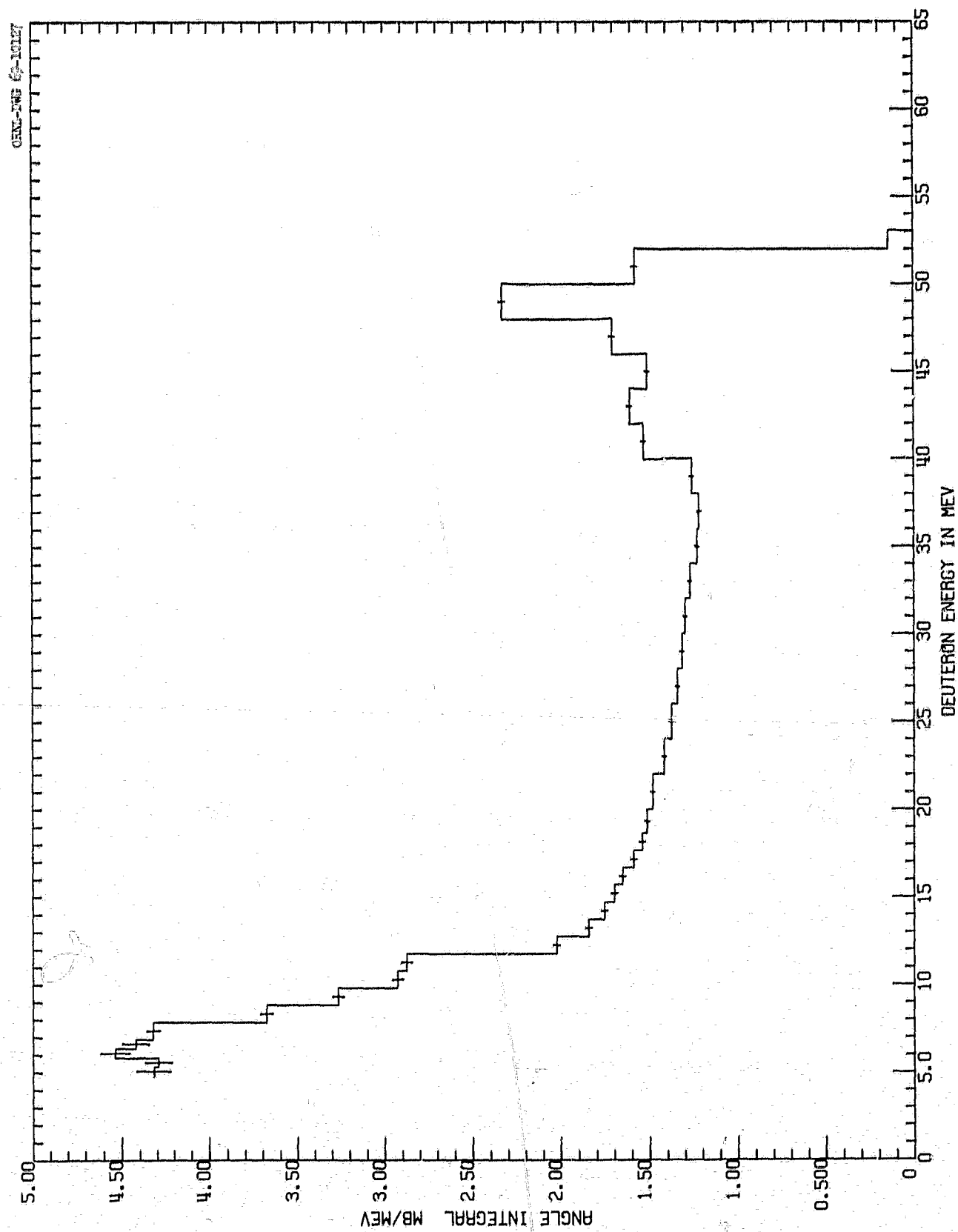


Fig. 4. Angle-integrated Deuteron Spectrum from  $^{56}\text{Fe}$

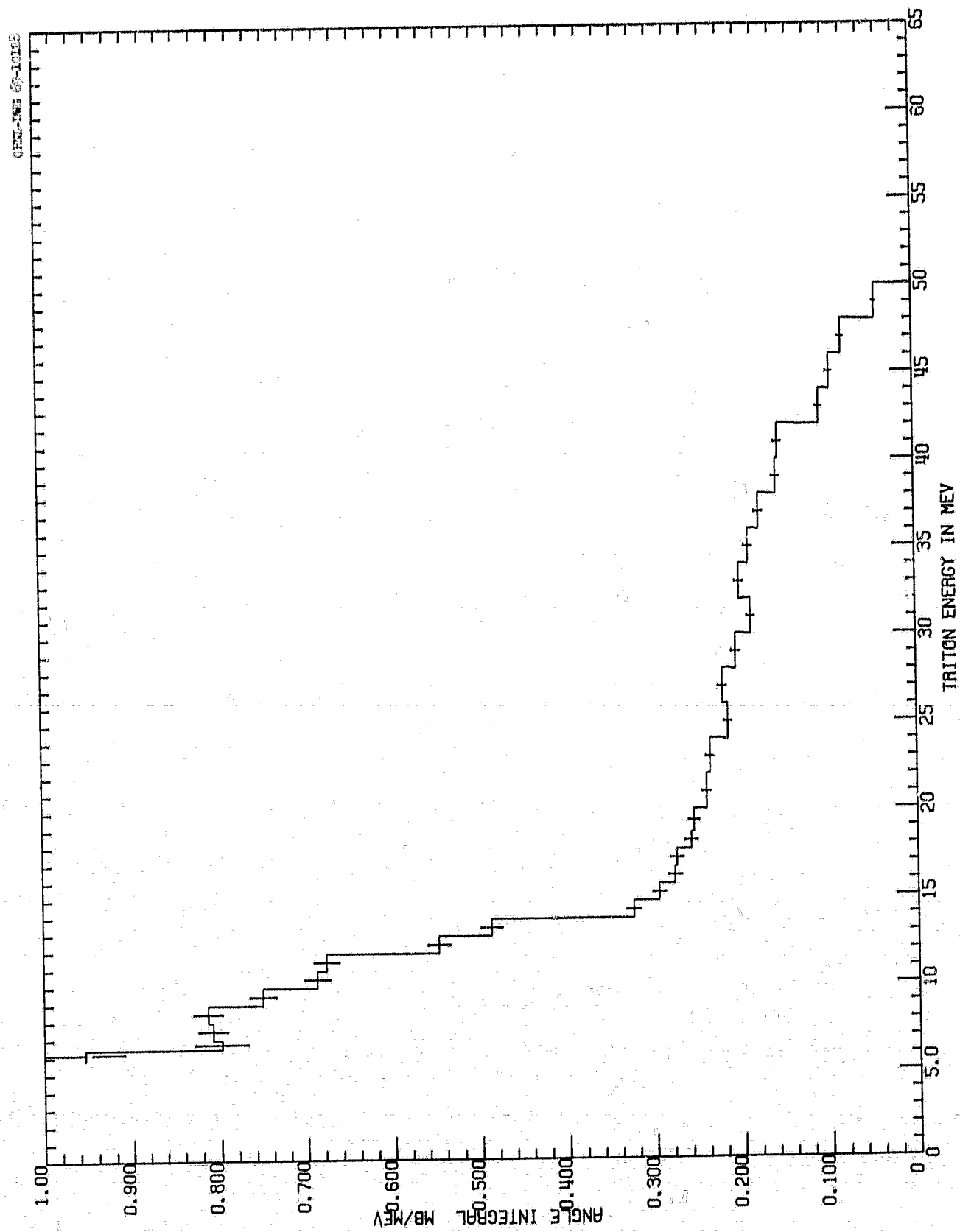


Fig. 5. Angle-integrated Triton Spectrum from  $^{56}\text{Fe}$



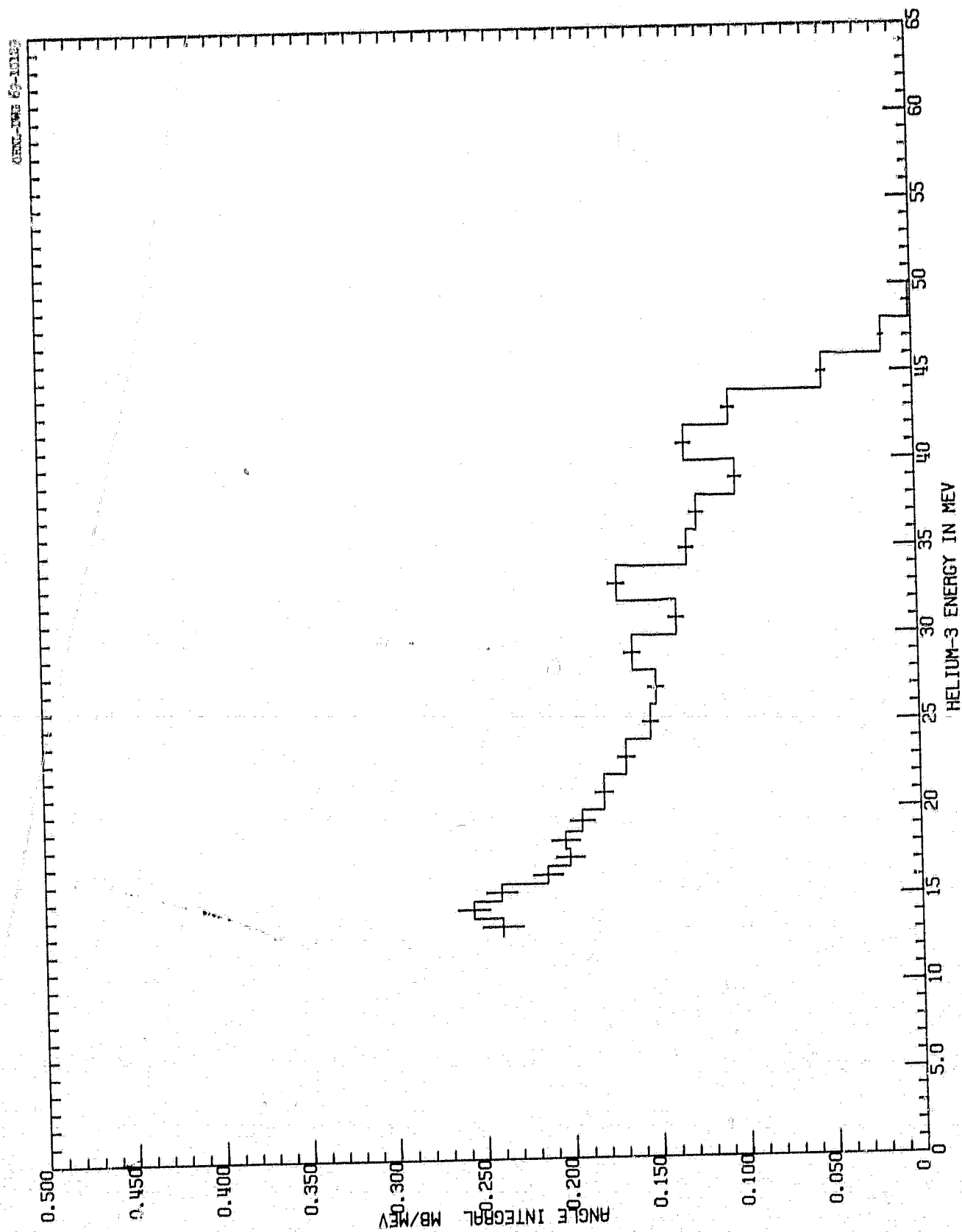


Fig. 6. Angle-integrated Helium-3 Spectrum from  $^{56}\text{Fe}$

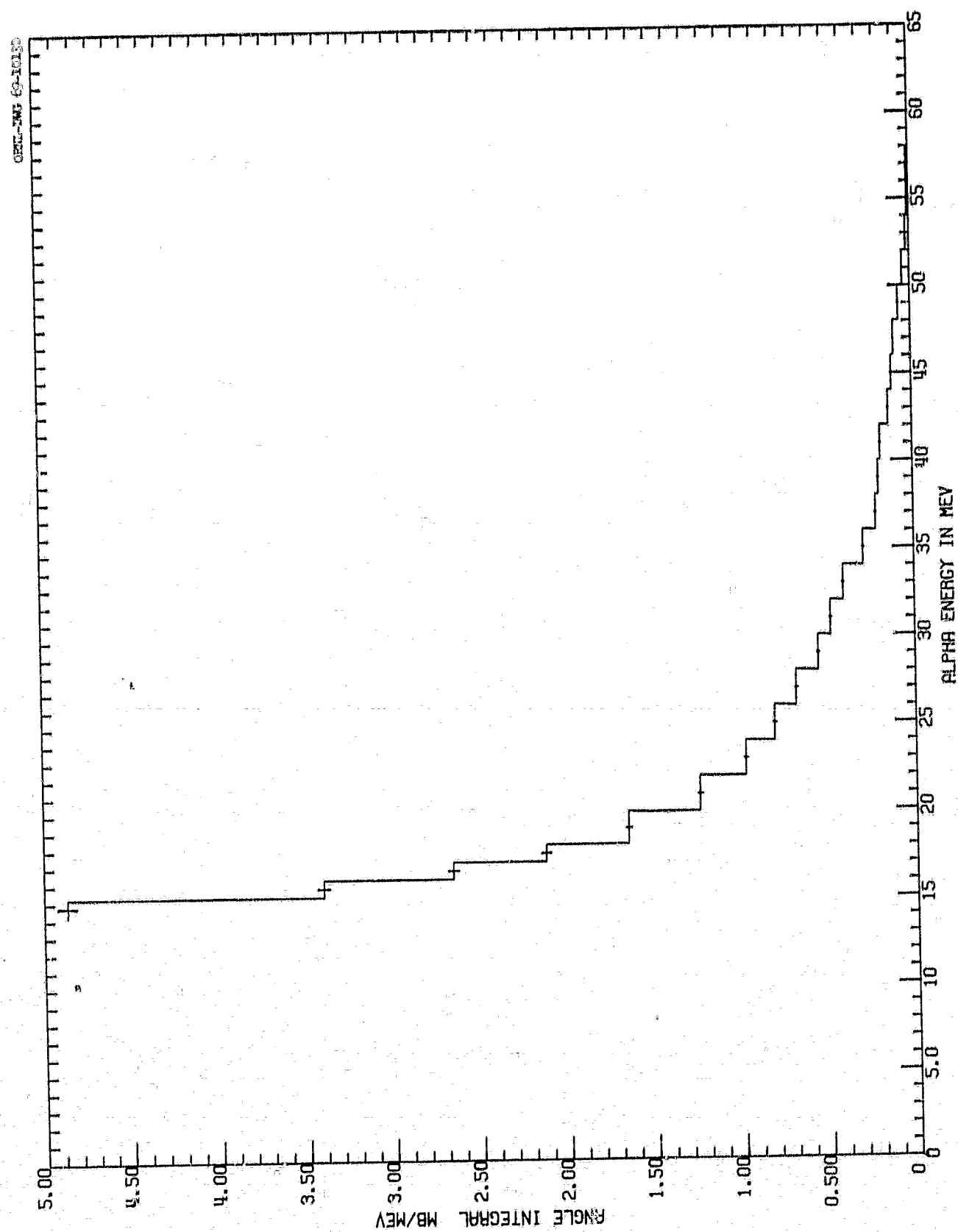


Fig. 7. Angle-integrated Alpha Spectrum from  $^{56}\text{Fe}$

Table 4.  $^{56}\text{Fe}(p,p)^{56}\text{Fe}$   
Elastic Scattering

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	2208.2	2128.7	0.1
20	20.3	427.16	412.15	0.1
22	22.3	127.85	123.51	0.1
25	25.4	42.21	40.77	0.1
30	30.5	98.22	94.99	0.1
37	37.6	55.53	54.49	0.2
45	45.6	10.75	10.46	0.4
52	52.7	8.15	7.96	0.3
60	60.9	4.64	4.55	0.5
75	76.0	0.959	0.954	1.0
90	91.1	0.171	0.171	2.7
120	121.0	0.0142	0.0145	5.9

Table 5.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$ 

0.85 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	12.90	12.45	20
20	20.3	12.65	12.22	15
22	22.3	12.30	11.87	20
25	25.9	9.26	8.93	15
30	30.5	3.15	3.05	10
37	37.6	2.77	2.68	15
45	45.6	2.14	2.08	5
52	52.7	1.10	1.08	2
60	60.9	0.523	0.513	2.1
75	76.0	0.144	0.143	3.8
90	91.1	0.106	0.106	3.5
120	121.0	0.0154	0.0157	5.6

Table 6.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$   
2.66 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	1.33	1.27	11.0
20	20.3	0.856	0.848	5.5
22	22.3	0.464	0.448	7.2
25	25.4	0.396	0.383	5.8
30	30.5	0.081	0.078	16.8
37	37.6	0.154	0.148	9.1
45	45.6	0.162	0.158	5.0
52	52.7	0.028	0.027	16.2
60	60.9	0.032	0.031	11.7
75	76.0	0.015	0.0148	12.8
90	91.1	0.0089	0.0089	14.1
120	121.0	0.0024	0.0025	14.4



Table 7.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$   
3.11 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	0.514	0.495	26.0
20	20.3	0.553	0.533	8.5
22	22.3	0.643	0.683	4.8
25	25.9	1.12	1.08	2.4
30	30.5	1.09	1.06	2.3
37	37.6	0.543	0.526	3.7
45	45.6	0.331	0.321	3.7
52	52.7	0.175	0.128	4.5
60	60.9	0.0693	0.0681	8.5
75	76.0	0.0173	0.0171	15.3

Table 8.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$   
4.55 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	4.36	4.20	4.0
20	20.3	5.94	5.71	1.4
22	22.3	6.12	5.89	1.1
25	25.4	6.53	6.30	1.5
30	30.5	3.96	3.83	1.1
37	37.6	0.852	0.826	2.9
45	45.7	0.854	0.831	2.0
52	52.8	0.528	0.515	2.1
60	60.9	0.282	0.277	3.3
75	76.0	0.094	0.093	4.5
90	91.1	0.031	0.031	8.5

Table 9.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$   
5.26 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	0.418	0.396	2.6
20	20.3	0.642	0.619	7.4
22	22.3	0.950	0.916	4.2
30	30.5	0.672	0.650	4.1
37	37.6	0.446	0.433	5.2
45	45.7	0.413	0.403	3.6
52	52.8	0.178	0.174	5.8
60	60.9	0.139	0.137	6.1
75	76.0	0.037	0.037	11.0
90	91.1	0.021	0.021	12.3
120	121.0	0.0040	0.0041	19.2

Table 10.  $^{56}\text{Fe}(p,p')^{56}\text{Fe}$   
6.79 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	0.765	0.737	15.9
20	20.3	0.709	0.684	7.7
25	25.4	0.864	0.833	3.2
30	30.5	0.862	0.832	3.5
37	37.6	0.146	0.141	13.6
45	45.6	0.160	0.156	8.6
52	52.8	0.072	0.070	14.2
60	60.9	0.054	0.053	28.4
75	76.0	0.028	0.028	13.5
90	91.1	0.046	0.046	39.9

Table 11.  $^{56}\text{Fe}(p,d)^{56}\text{Fe}$   
 Ground State  
 ( $Q = -8.97$  MeV)

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.3	0.941	0.890	6.3
20	20.5	0.930	0.883	3.1
25	25.7	0.676	0.643	1.9
30	30.8	0.280	0.267	3.4
37	38.0	0.147	0.141	4.7
45	46.1	0.089	0.086	4.9
52	53.2	0.031	0.030	7.8
60	61.4	0.041	0.040	6.0
75	76.5	0.0096	0.0094	12.0



Table 12.  $^{56}\text{Fe}(p,d)^{55}\text{Fe}$   
0.41 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	0.498	0.472	9.3
20	20.5	0.250	0.237	8.3
25	25.7	0.227	0.216	3.4
30	30.8	0.083	0.079	9.0
37	38.0	0.013	0.012	38.4
45	46.1	0.025	0.024	10.6
52	53.2	0.019	0.018	9.8
60	61.4	0.0065	0.0064	28.7
75	76.5	0.0023	0.0023	32.6

Table 13.  $^{56}\text{Fe}(p,d)^{55}\text{Fe}$   
0.93 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	0.692	0.655	8.7
20	20.5	0.591	0.560	4.8
25	25.7	0.462	0.439	2.6
30	30.8	0.246	0.235	4.6
37	38.0	0.054	0.052	12.2
45	46.1	0.100	0.096	5.0
52	53.2	0.048	0.046	8.4
60	61.4	0.022	0.022	11.9
75	76.4	0.0073	0.0072	17.9

Table 14.  $^{56}\text{Fe}(p,d)^{55}\text{Fe}$   
1.42 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	2.59	2.45	3.4
20	20.5	2.38	2.25	1.8
25	25.7	1.87	1.79	1.1
30	30.8	1.22	1.16	1.5
37	38.0	0.717	0.685	2.2
45	46.1	0.445	0.428	2.1
52	53.2	0.266	0.256	2.7
60	61.4	0.208	0.202	2.9
75	76.4	0.067	0.066	4.6

Table 15.  $^{58}\text{Fe}(p,d)^{57}\text{Fe}$   
2.99 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	0.813	0.768	6.3
20	20.5	0.733	0.694	3.5
25	25.7	0.571	0.543	2.4
30	30.8	0.328	0.312	4.0
37	38.0	0.233	0.223	4.3
45	46.1	0.136	0.130	4.4
52	53.3	0.108	0.104	4.8
60	61.4	0.064	0.063	5.8
75	76.5	0.024	0.024	9.6

Table 16.  $^{58}\text{Fe}(p,d)^{57}\text{Fe}$   
4.97 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	0.584	0.551	10.3
20	20.5	0.248	0.234	10.5
25	25.7	0.205	0.194	6.0
30	30.8	0.162	0.154	7.3
37	38.0	0.052	0.049	20.2
45	46.1	0.069	0.066	8.8
52	53.3	0.023	0.022	17.0

Table 17.  $^{56}\text{Fe}(p,d)^{55}\text{Fe}$   
7.86 MeV Level

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.4	0.480	0.452	11.7
20	20.5	0.458	0.432	6.1
25	25.7	0.371	0.351	3.9
30	30.8	0.189	0.179	6.9
37	38.0	0.120	0.115	13.0
45	46.1	0.097	0.093	7.2
52	53.3	0.069	0.066	7.9
60	61.4	0.032	0.032	14.0
75	76.5	0.026	0.025	10.1

Table 18.  $^{56}\text{Fe}(p,t)^{54}\text{Fe}$   
 Ground State  
 ( $Q = -12.02$  MeV)

Lab Angle (deg)	C.M. Angle (deg)	Cross Section (Lab) (mb/sr)	Cross Section (C.M.) (mb/sr)	Statistical Uncertainty ( $\pm$ %)
15	15.6	0.076	0.071	17.2
20	20.6	0.124	0.116	6.7
22	22.7	0.079	0.074	6.5
30	31.0	0.106	0.100	17.9
37	38.2	0.013	0.012	13.7
45	46.3	0.0122	0.0116	12.7
60	61.7	0.0071	0.0068	13.4

Table 19. Angle-Integrated Cross Sections

<sup>56</sup>Fe

Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)	Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)	Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)
<u>Protons</u>								
3.82	121.53	0.520	46.00	6.96	6.179	24.00	1.37	0.011
4.34	119.04	0.441	48.00	6.10	0.178	26.00	1.34	0.011
4.86	114.55	0.430	50.00	5.76	0.139	28.00	1.31	0.011
5.39	107.48	0.415	52.00	6.34	0.136	30.00	1.29	0.011
5.91	98.27	0.396	54.00	7.80	0.135	32.00	1.27	0.011
6.43	89.68	0.370	56.00	4.89	0.115	34.00	1.23	0.011
6.95	77.43	0.176	58.00	7.92	0.081	36.00	1.21	0.012
7.93	65.67	0.162	60.00	3.88	0.041	38.00	1.26	0.012
8.91	33.45	0.078	60.43			40.00	1.53	0.014
9.89	28.39	0.072				42.00	1.61	0.014
10.87	23.79	0.066				44.00	1.51	0.013
11.85	20.40	0.061				46.00	1.70	0.015
12.83	17.99	0.058				48.00	2.33	0.018
13.81	16.11	0.054				50.00	1.58	0.015
14.78	14.77	0.052	4.80	4.32	0.067	52.00	0.14	0.003
15.76	13.78	0.050	5.32	4.29	0.054	53.03		
16.74	13.16	0.049	5.84	4.54	0.055			
17.72	12.51	0.048	6.36	4.42	0.054			
18.70	11.93	0.041	6.89	4.32	0.039			
20.00	11.33	0.032	7.87	3.67	0.036			
22.00	10.70	0.031	8.84	3.26	0.033			
24.00	10.24	0.030	9.82	2.92	0.031			
26.00	9.78	0.030	10.80	2.87	0.031	5.91	0.954	0.031
28.00	9.40	0.039	11.78	2.02	0.019	6.43	0.798	0.022
30.00	8.99	0.051	12.76	1.84	0.018	6.95	0.808	0.016
32.00	8.65	0.069	13.74	1.75	0.018	7.93	0.813	0.016
34.00	8.32	0.092	14.72	1.70	0.018	8.91	0.751	0.016
36.00	8.19	0.112	15.70	1.65	0.018	9.89	0.687	0.015
38.00	8.25	0.137	16.68	1.59	0.017	10.87	0.677	0.014
40.00	8.36	0.137	17.66	1.54	0.017	11.85	0.547	0.013
42.00	8.31	0.137	18.64	1.51	0.014	12.83	0.487	0.012
44.00	7.81	0.157	20.00	1.48	0.012	13.81	0.332	0.008
			22.00	1.41	0.011	14.78	0.301	0.007
						15.76	0.279	0.007
<u>Deuterons</u>								
			4.80	4.32	0.067			
			5.32	4.29	0.054			
			5.84	4.54	0.055			
			6.36	4.42	0.054			
			6.89	4.32	0.039			
			7.87	3.67	0.036			
			8.84	3.26	0.033			
			9.82	2.92	0.031			
			10.80	2.87	0.031			
			11.78	2.02	0.019			
			12.76	1.84	0.018			
			13.74	1.75	0.018			
			14.72	1.70	0.018			
			15.70	1.65	0.018			
			16.68	1.59	0.017			
			17.66	1.54	0.017			
			18.64	1.51	0.014			
			20.00	1.48	0.012			
			22.00	1.41	0.011			

(continued on next page)



Table 19. (Cont.)

Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)	Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)	Bin Energy <sup>a</sup> (MeV)	Cross Section (mb/MeV)	Uncertainty (mb/MeV)
<u>Tritons</u>								
16.74	0.275	0.007	12.89	0.239	0.012	14.26	4.875	0.052
17.72	0.258	0.007	13.87	0.256	0.009	15.24	3.405	0.033
18.70	0.255	0.006	14.85	0.240	0.009	16.22	2.656	0.029
20.00	0.241	0.005	15.83	0.213	0.008	17.20	2.125	0.026
22.00	0.235	0.005	16.81	0.200	0.008	18.18	1.650	0.017
24.00	0.215	0.004	17.79	0.203	0.008	20.00	1.244	0.014
26.00	0.220	0.005	18.77	0.193	0.007	22.00	0.977	0.012
28.00	0.206	0.005	20.00	0.181	0.005	24.00	0.811	0.011
30.00	0.188	0.004	22.00	0.167	0.005	26.00	0.686	0.010
32.00	0.200	0.005	24.00	0.153	0.005	28.00	0.557	0.009
34.00	0.193	0.004	26.00	0.150	0.005	30.00	0.481	0.008
36.00	0.183	0.004	28.00	0.163	0.005	32.00	0.407	0.007
38.00	0.167	0.004	30.00	0.137	0.004	34.00	0.291	0.006
40.00	0.165	0.004	32.00	0.171	0.005	36.00	0.217	0.005
42.00	0.129	0.004	34.00	0.131	0.004	38.00	0.199	0.005
44.00	0.117	0.003	36.00	0.125	0.004	40.00	0.185	0.005
46.00	0.114	0.003	38.00	0.102	0.004	42.00	0.138	0.004
48.00	0.089	0.002	40.00	0.131	0.004	44.00	0.116	0.004
50.00	0.046	0.010	42.00	0.106	0.004	46.00	0.102	0.004
50.03			44.00	0.052	0.003	48.00	0.072	0.003
			46.00	0.017	0.001	50.00	0.046	0.002
			48.00	0.002	0.000	52.00	0.022	0.002
			50.00	0.001	0.003	54.00	0.011	0.001
			50.03			56.00	0.014	0.001
						58.00	0.002	0.001
						60.03		
<u>Helium-3</u>								
<u>Alpha</u>								

a) Bin energy listed is the low-energy edge of the bin. The highest bin energy listed is the upper edge of the last bin.

Table 20. Energy Integrated Differential Cross Sections

<sup>56</sup>Fe - 61-MeV Incident Protons

Lab Angle	Proton <sup>a</sup>		Deuteron		Triton		Helium-3		Alpha	
	$\sigma \pm \Delta\sigma^c$ (mb/sr)	COE <sup>b</sup> (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	COE <sup>b</sup> (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	COE <sup>b</sup> (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	COE <sup>b</sup> (MeV)	$\sigma \pm \Delta\sigma^c$ (mb/sr)	COE <sup>b</sup> (MeV)
15			34.7 ± 0.3	11.49	3.47 ± 0.1	13.43				
20	171.0 ± 8.6 <sup>d</sup>	8.47	29.1 ± 0.1	11.50	2.67 ± 0.04	13.43				
22			27.0 ± 0.1	4.80	6.68 ± 0.05	5.91	1.27 ± 0.02	12.85	6.2 ± 0.1	14.22
30	128.6 ± 2.2 <sup>d</sup>	8.48	16.2 ± 0.1	11.51	1.94 ± 0.02	13.44				
37	149.5 ± 2.8 <sup>d</sup>	3.85	14.4 ± 0.1	4.83	1.87 ± 0.02	5.99	1.10 ± 0.02	12.93	4.91 ± 0.03	14.30
45	84.7 ± 0.1	8.48	9.20 ± 0.1	11.51	1.16 ± 0.01	13.44				
52	116.9 ± 0.1	3.85	10.4 ± 0.03	4.83	1.44 ± 0.01	5.94	0.75 ± 0.01	12.93	3.98 ± 0.02	14.30
60	53.2 ± 0.1	8.48	5.87 ± 0.02	11.51	0.68 ± 0.01	13.44				
76	70.0 ± 0.1	3.86	5.00 ± 0.02	4.90	0.66 ± 0.01	5.95	0.31 ± 0.01	13.01	1.94 ± 0.01	14.38
90	25.1 ± 0.1	8.54	2.06 ± 0.01	11.57	0.21 ± 0.01	13.51				
120	15.2 ± 0.1	8.50	0.87 ± 0.01	11.53	0.08 ± 0.01	13.47				
135	47.4 ± 0.1	3.70	1.91 ± 0.01	4.79	0.25 ± 0.01	5.44	0.09 ± 0.005	12.28	0.81 ± 0.01	13.83

a) does not include elastic scattering

b) COE ≡ Cutoff energy

c) statistical uncertainty

d) error includes uncertainty in tail correction - see text

Table 21. Total Cross Sections

 $^{56}\text{Fe}$  - 61-MeV Incident Protons

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Proton <sup>a</sup>	$1016 \pm 4$	millibarns	$E_p > 3.82 \text{ MeV}$
Deuteron	$86.7 \pm 0.2$	millibarns	$E_D > 4.80 \text{ MeV}$
Triton	$12.7 \pm 0.1$	millibarns	$E_T > 5.91 \text{ MeV}$
Helium	$5.1 \pm 0.04$	millibarns	$E_{\text{He}} > 12.89 \text{ MeV}$
Alpha	$29.0 \pm 0.1$	millibarns	$E_\alpha > 14.26 \text{ MeV}$

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a) The proton cross section does not include elastic scattering

Table 22.

PROTON FROM A = 56 BOMBARDED BY 61 MEV. PROTONS.

20 DEG - RUN 1120				30 DEG - RUN 1127				37 DEG - RUN 1127				45 DEG - RUN 1126				52 DEG - RUN 1126			
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	
8.95	1.40	0.03		8.95	4.16	0.03		4.08	9.93	0.06		8.95	3.85	0.03		4.02	10.19	0.05	
9.94	3.00	0.04		9.94	2.46	0.02		4.60	10.12	0.07		9.95	3.24	0.02		4.60	10.71	0.05	
10.93	2.72	0.04		10.94	3.17	0.03		5.12	10.23	0.07		10.94	2.73	0.02		5.12	10.56	0.05	
11.92	2.52	0.04		11.93	2.67	0.03		5.65	9.87	0.06		11.93	2.38	0.02		5.65	10.16	0.05	
12.91	2.54	0.04		12.92	2.45	0.02		6.17	9.24	0.06		12.92	2.19	0.02		6.17	9.53	0.04	
13.91	2.46	0.04		13.91	2.28	0.03		6.69	8.83	0.06		13.92	2.01	0.02		6.69	8.84	0.04	
14.89	2.20	0.03		14.90	2.17	0.02		7.44	8.08	0.04		14.91	1.80	0.02		7.44	7.73	0.03	
15.88	2.28	0.03		15.90	2.15	0.02		8.42	6.54	0.04		15.93	1.79	0.02		8.42	6.57	0.03	
16.88	2.398	0.036		16.89	2.116	0.025		9.47	6.54	0.04		16.89	1.767	0.018		9.43	6.48	0.020	
17.87	2.441	0.036		17.88	2.113	0.025		10.38	6.701	0.029		17.88	1.759	0.018		10.38	6.305	0.019	
18.86	2.777	0.035		18.87	2.120	0.025		11.36	6.205	0.027		18.88	1.758	0.018		11.36	6.318	0.018	
19.85	2.483	0.036		19.86	2.188	0.025		12.34	6.205	0.027		19.87	1.727	0.018		12.34	6.441	0.016	
20.84	2.553	0.037		20.85	2.162	0.025		13.32	6.205	0.027		20.85	1.706	0.018		13.32	6.416	0.016	
21.83	2.584	0.037		21.85	2.137	0.025		14.30	6.205	0.027		21.85	1.744	0.018		14.29	6.415	0.015	
22.82	2.641	0.037		22.84	2.179	0.025		15.28	6.205	0.027		22.85	1.711	0.018		15.27	6.415	0.015	
23.81	2.635	0.037		23.83	2.260	0.026		16.25	6.205	0.027		23.84	1.721	0.018		16.25	6.414	0.014	
24.80	2.691	0.038		24.82	2.285	0.026		17.23	6.205	0.027		24.83	1.706	0.018		17.23	6.414	0.014	
25.79	2.686	0.038		25.82	2.313	0.026		18.21	6.205	0.027		25.82	1.726	0.018		18.21	6.414	0.014	
26.78	2.766	0.038		26.81	2.308	0.026		19.19	6.205	0.027		26.81	1.722	0.018		19.19	6.414	0.014	
27.77	2.793	0.039		27.80	2.305	0.026		20.17	6.205	0.027		27.81	1.703	0.018		20.17	6.414	0.014	
28.77	2.843	0.040		28.79	2.328	0.026		21.15	6.205	0.027		28.80	1.716	0.018		21.15	6.413	0.013	
29.76	2.825	0.040		29.78	2.368	0.026		22.13	6.205	0.027		29.79	1.714	0.018		22.13	6.413	0.013	
30.75	2.825	0.040		30.78	2.442	0.027		23.11	6.205	0.027		30.78	1.669	0.018		23.11	6.404	0.013	
31.74	2.871	0.040		31.77	2.400	0.027		24.09	6.205	0.027		31.78	1.659	0.018		24.09	6.413	0.013	
32.73	2.874	0.040		32.76	2.461	0.027		25.07	6.205	0.027		32.77	1.677	0.018		25.07	6.413	0.013	
33.72	2.880	0.040		33.75	2.450	0.027		26.05	6.205	0.027		33.76	1.623	0.017		26.05	6.413	0.013	
34.71	2.800	0.040		34.74	2.480	0.027		27.03	6.205	0.027		34.75	1.615	0.017		27.03	6.413	0.013	
35.70	2.800	0.040		35.74	2.590	0.027		28.01	6.205	0.027		35.74	1.626	0.017		28.01	6.413	0.013	
36.69	2.800	0.040		36.73	2.570	0.027		29.00	6.205	0.027		36.74	1.626	0.017		29.00	6.413	0.013	
37.68	2.800	0.040		37.72	2.670	0.027		29.98	6.205	0.027		37.73	1.636	0.017		29.98	6.413	0.013	
38.67	2.800	0.040		38.71	2.800	0.027		30.94	6.205	0.027		38.72	1.625	0.017		30.94	6.413	0.013	
39.66	2.800	0.040		39.70	2.860	0.027		31.92	6.205	0.027		39.71	1.627	0.017		31.92	6.413	0.013	
40.65	2.800	0.040		40.70	3.030	0.027		32.90	6.205	0.027		40.71	1.619	0.017		32.90	6.413	0.013	
41.64	2.800	0.040		41.69	2.930	0.027		33.88	6.205	0.027		41.70	1.676	0.016		33.88	6.413	0.012	
42.63	2.800	0.040		42.68	3.040	0.027		34.86	6.205	0.027		42.69	1.600	0.017		34.85	6.413	0.012	
43.62	2.800	0.040		43.67	2.960	0.027		35.84	6.205	0.027		43.68	1.629	0.017		35.83	6.413	0.012	
44.61	2.800	0.040		44.66	2.880	0.027		36.82	6.205	0.027		44.67	1.593	0.017		36.81	6.413	0.012	
45.60	2.800	0.040		45.66	2.680	0.027		37.80	6.205	0.027		45.67	1.654	0.016		37.79	6.413	0.012	
46.59	2.800	0.040		46.65	2.630	0.027		38.78	6.205	0.027		46.66	1.598	0.016		38.77	6.413	0.012	
47.58	2.800	0.040		47.64	2.360	0.027		39.76	6.205	0.027		47.65	1.543	0.015		39.75	6.413	0.012	
48.57	2.800	0.040		48.63	2.270	0.027		40.73	6.205	0.027		48.64	1.587	0.015		40.73	6.413	0.012	
49.56	2.800	0.040		49.62	2.270	0.027		41.71	6.205	0.027		49.63	1.507	0.015		41.71	6.413	0.012	
50.55	2.800	0.040		50.62	2.300	0.027		42.69	6.205	0.027		50.63	1.533	0.014		42.69	6.413	0.011	
51.54	2.800	0.040		51.61	2.300	0.027		43.67	6.205	0.027		51.62	1.507	0.014		43.67	6.413	0.011	
52.53	2.800	0.040		52.60	2.700	0.027		44.65	6.205	0.027		52.61	1.508	0.014		44.64	6.413	0.011	
53.52	2.800	0.040		53.59	2.860	0.027		45.63	6.205	0.027		53.60	1.530	0.014		45.62	6.413	0.011	
54.51	2.800	0.040		54.58	1.860	0.027		46.61	6.205	0.027		54.60	1.569	0.015		46.60	6.413	0.011	
55.50	2.800	0.040		55.58	5.810	0.027		47.59	6.205	0.027		55.59	1.540	0.015		47.58	6.413	0.010	
56.49	2.800	0.040		56.57	1.480	0.027		48.57	6.205	0.027		56.58	1.530	0.015		48.56	6.413	0.010	
57.48	2.800	0.040		57.56	1.190	0.027		49.55	6.205	0.027		57.57	1.433	0.015		49.54	6.413	0.010	
58.47	2.800	0.040		58.55	0.700	0.027		50.53	6.205	0.027		58.56	1.480	0.015		50.52	6.413	0.010	
59.46	2.800	0.040		59.54	4.700	0.027		51.51	6.205	0.027		59.53	1.433	0.015		51.50	6.413	0.009	
60.45	2.800	0.040		60.53	0.000	0.000		52.49	6.205	0.027		60.52	0.000	0.000		52.48	6.413	0.009	
61.44	2.800	0.040		61.52	0.000	0.000		53.46	6.205	0.027		61.51	0.000	0.000		53.46	6.413	0.009	
62.43	2.800	0.040		62.50	0.000	0.000		54.44	6.205	0.027		62.49	0.000	0.000		54.44	6.413	0.009	
63.42	2.800	0.040		63.58	0.000	0.000		55.42	6.205	0.027		63.47	0.000	0.000		55.41	6.413		

Table 22 (continued)

PHOTON FROM A = 50 BOMBARDED BY 51 MEV. PROTONS.

60 DEG - RUN 1153			75 DEG - RUN 3007			90 DEG - RUN 1334			120 DEG - RUN 1140			135 DEG - RUN 4013		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
8.95	3.30	0.02	4.08	9.11	0.04	9.02	2.05	0.02	8.97	2.35	0.01	3.87	9.17	0.05
9.94	2.82	0.02	4.61	9.22	0.04	10.01	2.25	0.02	9.96	1.84	0.01	4.27	9.21	0.05
10.93	2.39	0.02	5.13	8.96	0.04	11.00	1.84	0.01	10.96	1.45	0.01	4.67	8.95	0.05
11.92	2.03	0.02	5.65	8.45	0.04	12.00	1.55	0.01	11.95	1.17	0.01	5.07	8.44	0.05
12.92	1.83	0.02	6.18	7.75	0.04	12.99	1.33	0.01	12.94	0.97	0.01	5.47	7.89	0.04
13.91	1.67	0.01	6.71	7.06	0.04	13.98	1.17	0.01	13.94	0.82	0.01	5.87	7.22	0.04
14.90	1.52	0.01	7.25	6.07	0.02	14.98	1.02	0.01	14.93	0.72	0.01	6.27	6.54	0.04
15.89	1.45	0.01	7.78	5.06	0.02	15.97	0.84	0.01	15.93	0.62	0.01	6.67	6.09	0.04
16.89	1.41	0.01	8.31	4.41	0.02	16.96	0.87	0.01	16.92	0.54	0.01	7.36	5.01	0.02
17.89	1.35	0.01	8.84	3.78	0.01	17.96	0.80	0.01	17.91	0.49	0.01	8.26	4.35	0.02
18.87	1.31	0.01	9.37	3.15	0.01	18.95	0.73	0.01	18.91	0.45	0.01	9.36	2.20	0.01
19.86	1.25	0.01	9.90	2.52	0.01	19.94	0.73	0.01	19.93	0.45	0.01	10.36	1.61	0.01
20.85	1.21	0.01	10.43	1.88	0.01	20.94	0.64	0.01	20.89	0.36	0.01	11.36	1.32	0.01
21.84	1.18	0.01	10.96	1.28	0.01	21.93	0.61	0.01	21.89	0.32	0.01	12.36	1.08	0.01
22.84	1.14	0.01	11.49	1.18	0.01	22.92	0.57	0.01	22.88	0.29	0.01	13.36	0.87	0.01
23.83	1.11	0.01	12.02	1.08	0.01	23.92	0.52	0.01	23.88	0.27	0.01	14.35	0.72	0.01
24.82	1.08	0.01	12.55	0.95	0.01	24.91	0.51	0.01	24.87	0.23	0.01	15.35	0.61	0.01
25.81	1.05	0.01	13.08	0.85	0.01	25.90	0.45	0.01	25.86	0.22	0.01	16.35	0.52	0.01
26.80	1.02	0.01	13.61	0.76	0.01	26.90	0.44	0.01	26.86	0.20	0.01	17.35	0.46	0.01
27.80	1.00	0.01	14.14	0.68	0.01	27.89	0.42	0.01	27.85	0.17	0.01	18.35	0.40	0.01
28.79	0.97	0.01	14.67	0.60	0.01	28.88	0.42	0.01	28.85	0.16	0.01	19.35	0.35	0.01
29.78	0.95	0.01	15.20	0.52	0.01	29.88	0.37	0.01	29.84	0.14	0.01	20.35	0.31	0.01
30.77	0.93	0.01	15.73	0.44	0.01	30.87	0.34	0.01	30.83	0.13	0.01	21.35	0.27	0.01
31.76	0.91	0.01	16.26	0.36	0.01	31.86	0.32	0.01	31.83	0.11	0.01	22.34	0.23	0.01
32.75	0.89	0.01	16.79	0.28	0.01	32.86	0.30	0.01	32.82	0.10	0.01	23.34	0.20	0.01
33.74	0.87	0.01	17.32	0.20	0.01	33.85	0.28	0.01	33.81	0.09	0.01	24.34	0.18	0.01
34.73	0.85	0.01	17.85	0.12	0.01	34.94	0.25	0.01	34.89	0.08	0.01	25.34	0.15	0.01
35.72	0.83	0.01	18.38	0.04	0.01	35.84	0.24	0.01	35.80	0.07	0.01	26.34	0.13	0.01
36.71	0.81	0.01	18.91	0.00	0.01	36.83	0.22	0.01	36.80	0.05	0.01	27.34	0.12	0.01
37.70	0.79	0.01	19.44	0.00	0.01	37.82	0.22	0.01	37.79	0.05	0.01	28.34	0.10	0.01
38.69	0.77	0.01	20.00	0.00	0.01	38.82	0.19	0.01	38.78	0.05	0.01	29.33	0.09	0.01
39.68	0.75	0.01	20.53	0.00	0.01	39.81	0.19	0.01	39.78	0.04	0.01	30.33	0.08	0.01
40.67	0.73	0.01	21.06	0.00	0.01	40.80	0.15	0.01	40.77	0.04	0.01	31.33	0.08	0.01
41.66	0.71	0.01	21.59	0.00	0.01	41.80	0.15	0.01	41.76	0.03	0.01	32.33	0.06	0.01
42.65	0.69	0.01	22.12	0.00	0.01	42.79	0.14	0.01	42.76	0.03	0.01	33.33	0.06	0.01
43.64	0.67	0.01	22.65	0.00	0.01	43.78	0.13	0.01	43.75	0.02	0.01	34.33	0.06	0.01
44.63	0.65	0.01	23.18	0.00	0.01	44.78	0.13	0.01	44.75	0.02	0.01	35.33	0.04	0.01
45.62	0.63	0.01	23.71	0.00	0.01	45.77	0.13	0.01	45.74	0.02	0.01	36.32	0.04	0.01
46.61	0.61	0.01	24.24	0.00	0.01	46.76	0.13	0.01	46.73	0.01	0.01	37.32	0.03	0.01
47.60	0.59	0.01	24.77	0.00	0.01	47.76	0.13	0.01	47.73	0.01	0.01	38.32	0.03	0.01
48.59	0.57	0.01	25.30	0.00	0.01	48.75	0.13	0.01	48.72	0.01	0.01	39.32	0.02	0.01
49.58	0.55	0.01	25.83	0.00	0.01	49.74	0.13	0.01	49.71	0.01	0.01	40.32	0.02	0.01
50.57	0.53	0.01	26.36	0.00	0.01	50.74	0.13	0.01	50.71	0.01	0.01	41.32	0.02	0.01
51.56	0.51	0.01	26.89	0.00	0.01	51.73	0.13	0.01	51.70	0.01	0.01	42.32	0.01	0.01
52.55	0.49	0.01	27.42	0.00	0.01	52.72	0.13	0.01	52.70	0.01	0.01	43.31	0.01	0.01
53.54	0.47	0.01	27.95	0.00	0.01	53.72	0.13	0.01	53.69	0.01	0.01	44.31	0.01	0.01
54.53	0.45	0.01	28.48	0.00	0.01	54.71	0.13	0.01	54.68	0.01	0.01	45.31	0.01	0.01
55.52	0.43	0.01	29.01	0.00	0.01	55.70	0.13	0.01	55.68	0.01	0.01	46.31	0.01	0.01
56.51	0.41	0.01	29.54	0.00	0.01	56.70	0.13	0.01	56.67	0.01	0.01	47.31	0.01	0.01
57.50	0.39	0.01	30.07	0.00	0.01	57.54	0.13	0.01	57.51	0.01	0.01	48.31	0.01	0.01
58.49	0.37	0.01	30.60	0.00	0.01	58.53	0.13	0.01	58.50	0.01	0.01	49.31	0.01	0.01
59.48	0.35	0.01	31.13	0.00	0.01	59.52	0.13	0.01	59.49	0.01	0.01	50.30	0.01	0.01
60.47	0.33	0.01	31.66	0.00	0.01	60.51	0.13	0.01	60.48	0.01	0.01	51.30	0.01	0.01
61.46	0.31	0.01	32.19	0.00	0.01	61.50	0.13	0.01	61.47	0.01	0.01	52.30	0.01	0.01
62.45	0.29	0.01	32.72	0.00	0.01	62.49	0.13	0.01	62.46	0.01	0.01	53.30	0.01	0.01
63.44	0.27	0.01	33.25	0.00	0.01	63.48	0.13	0.01	63.45	0.01	0.01	54.30	0.01	0.01
64.43	0.25	0.01	33.78	0.00	0.01	64.47	0.13	0.01	64.44	0.01	0.01	55.30	0.01	0.01
65.42	0.23	0.01	34.31	0.00	0.01	65.46	0.13	0.01	65.43	0.01	0.01	56.30	0.01	0.01
66.41	0.21	0.01	34.84	0.00	0.01	66.45	0.13	0.01	66.42	0.01	0.01	57.30	0.01	0.01
67.40	0.19	0.01	35.37	0.00	0.01	67.44	0.13	0.01	67.41	0.01	0.01	58.30	0.01	0.01
68.39	0.17	0.01	35.90	0.00	0.01	68.43	0.13	0.01	68.40	0.01	0.01	59.30	0.01	0.01
69.38	0.15	0.01	36.43	0.00	0.01	69.42	0.13	0.01	69.39	0.01	0.01	60.30	0.01	0.01
70.37	0.13	0.01	36.96	0.00	0.01	70.41	0.13	0.01	70.38	0.01	0.01	61.30	0.01	0.01
71.36	0.11	0.01	37.49	0.00	0.01	71.40	0.13	0.01	71.37	0.01	0.01	62.30	0.01	0.01
72.35	0.09	0.01	38.02	0.00	0.01	72.39	0.13	0.01	72.36	0.01	0.01	63.30	0.01	0.01
73.34	0.07	0.01	38.55	0.00	0.01	73.38	0.13	0.01	73.35	0.01	0.01	64.30	0.01	0.01
74.33	0.05	0.01	39.08	0.00	0.01	74.37	0.13	0.01	74.34	0.01	0.01	65.30	0.01	0.01
75.32	0.03	0.01	39.61	0.00	0.01	75.36	0.13	0.01	75.33	0.01	0.01	66.30	0.01	0.01
76.31	0.01	0.01	40.14	0.00	0.01	76.35	0.13	0.01	76.32	0.01	0.01	67.30	0.01	0.01
77.30	0.00	0.01	40.67	0.00	0.01	77.34	0.13	0.01	77.31	0.01	0.01	68.30	0.01	0.01
78.29	0.00	0.01	41.20	0.00	0.01	78.33	0.13	0.01	78.30	0.01	0.01	69.30	0.01	0.01
79.28	0.00	0.01	41.73	0.00	0.01	79.32	0.13	0.01	79.29	0.01	0.01	70.30	0.01	0.01
80.27	0.00	0.01	42.26	0.00	0.01	80.31	0.13	0.01	80.28	0.01	0.01	71.30	0.01	0.01
81.26	0.00	0.01	42.79	0.00	0.01	81.30	0.13	0.01	81.27	0.01	0.01	72.30	0.01	0.01
82.25	0.00	0.01	43.32	0.00	0.01	82.29	0.13	0.01	82.26	0.01	0.01	73.30	0.01	0.01
83.24	0.00	0.01	43.85	0.00	0.01	83.28	0.13	0.01	83.25	0.01	0.01	74.30	0.01	0.01
84.23	0.00	0.01	44.38	0.00	0.01	84.27	0.13	0.01	84.24	0.01	0.01	75.30	0.01	0.01
85.22	0.00	0.01	44.91	0.00	0.01	85.26	0.13	0.01	85.23	0.01	0.01	76.30	0.01	0.01
86.21	0.00	0.01	45.44	0.00	0.01	86.25	0.13	0.01	86.22	0.01	0.01	77.30	0.01	0.01
87.20	0.00	0.01	45.97	0.00	0.01	87.24	0.13	0.01	87.21	0.01	0.01	78.30	0.01	0.01
88.19	0.00	0.01	46.50	0.00	0.01	88.23	0.13	0.01	88.20	0.01	0.01	79.30	0.01	0.01
89.18	0.00	0.01	47.03	0.00	0.01	89.22	0.13	0.01	89.19	0.01	0.01	80.30	0.01	

Table 23

DEUTERON FROM A = 56 BOMBARDED BY 51 MEV. PROTONS.

15 DEG - RUN 1131			22 DEG - RUN 1130			30 DEG - RUN 1127			37 DEG - RUN 3010		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
11.96	0.35	0.028	11.97	0.106	0.008	5.02	0.552	0.018	11.98	0.371	0.010
12.95	0.360	0.028	12.96	0.164	0.009	5.54	0.636	0.019	12.97	0.322	0.010
13.95	0.320	0.026	13.95	0.256	0.012	6.06	0.757	0.021	13.96	0.330	0.010
14.94	0.360	0.028	14.94	0.208	0.011	6.58	0.820	0.022	14.95	0.315	0.010
15.93	0.412	0.030	15.93	0.244	0.011	7.32	0.911	0.017	15.95	0.327	0.010
16.92	0.347	0.027	16.92	0.315	0.013	8.29	0.579	0.014	16.94	0.329	0.010
17.91	0.415	0.033	17.92	0.361	0.014	9.26	0.496	0.013	17.93	0.333	0.010
18.90	0.386	0.029	18.91	0.366	0.014	10.24	0.359	0.011	18.92	0.324	0.010
19.89	0.421	0.030	19.90	0.363	0.014	11.21	0.304	0.010	19.91	0.331	0.010
20.88	0.421	0.031	20.89	0.398	0.015	12.18	0.298	0.013	20.91	0.333	0.010
21.87	0.421	0.031	21.88	0.414	0.015	13.15	0.230	0.009	21.90	0.365	0.010
22.86	0.421	0.031	22.87	0.426	0.015	14.12	0.235	0.009	22.89	0.346	0.010
23.85	0.421	0.031	23.86	0.432	0.015	15.09	0.313	0.010	23.88	0.349	0.010
24.84	0.521	0.034	24.85	0.440	0.015	16.07	0.322	0.010	24.87	0.354	0.010
25.84	0.461	0.032	25.85	0.433	0.015	17.04	0.323	0.010	25.87	0.363	0.010
26.82	0.521	0.034	26.84	0.481	0.016	18.01	0.351	0.011	26.86	0.343	0.010
27.82	0.525	0.034	27.83	0.494	0.016	18.98	0.325	0.010	27.85	0.330	0.010
28.81	0.523	0.034	28.82	0.456	0.016	19.95	0.322	0.010	28.84	0.357	0.010
29.80	0.537	0.034	29.81	0.504	0.016	20.92	0.346	0.010	29.83	0.349	0.010
30.79	0.537	0.034	30.80	0.499	0.017	21.90	0.345	0.010	30.82	0.356	0.010
31.78	0.628	0.037	31.79	0.542	0.017	22.87	0.350	0.011	31.82	0.356	0.010
32.77	0.777	0.039	32.78	0.557	0.017	23.84	0.359	0.011	32.81	0.343	0.010
33.76	0.646	0.037	33.77	0.569	0.017	24.81	0.334	0.011	33.80	0.358	0.010
34.75	0.659	0.038	34.77	0.643	0.019	25.78	0.401	0.011	34.79	0.367	0.010
35.74	0.707	0.039	35.76	0.665	0.019	26.75	0.494	0.012	35.79	0.359	0.010
36.73	0.791	0.042	36.75	0.618	0.018	27.73	0.530	0.013	36.78	0.372	0.010
37.72	0.830	0.043	37.74	0.601	0.019	28.70	0.525	0.013	37.77	0.364	0.010
38.72	0.863	0.043	38.73	0.706	0.019	29.67	0.458	0.012	38.76	0.368	0.010
39.71	0.910	0.045	39.72	0.738	0.020	30.64	0.496	0.014	39.75	0.400	0.011
40.70	1.444	0.056	40.71	1.319	0.026	31.61	0.537	0.014	40.75	0.511	0.012
41.69	1.191	0.051	41.70	0.873	0.022	32.58	0.539	0.013	41.74	0.390	0.011
42.68	1.066	0.048	42.70	0.872	0.022	33.56	0.454	0.012	42.73	0.512	0.012
43.67	1.478	0.057	43.69	1.380	0.027	34.53	0.419	0.011	43.72	0.477	0.012
44.66	0.915	0.045	44.68	0.858	0.021	35.50	0.446	0.012	44.71	0.396	0.011
45.65	1.418	0.056	45.67	1.089	0.024	36.47	0.434	0.011	45.71	0.616	0.013
46.64	2.338	0.071	46.66	2.068	0.033	37.44	0.442	0.012	46.70	0.337	0.010
47.63	0.982	0.046	47.65	0.939	0.022	38.41	0.445	0.012	47.69	0.596	0.013
48.62	1.571	0.058	48.64	1.185	0.025	39.39	0.490	0.012	48.68	0.257	0.009
49.61	3.553	0.088	49.63	3.227	0.041	40.36	0.551	0.013	49.67	1.638	0.022
50.61	2.154	0.068	50.63	1.671	0.030	41.33	0.698	0.015	50.67	0.444	0.011
51.45	2.058	0.079	51.44	1.223	0.032	42.30	0.917	0.017	51.39	0.060	0.006
0.0	0.0	0.0	0.0	0.0	0.0	43.27	0.798	0.016	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	44.24	1.131	0.019	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	45.22	0.825	0.016	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	46.19	0.894	0.017	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	47.16	1.077	0.018	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	48.13	0.971	0.017	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	49.10	0.921	0.017	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	50.07	0.701	0.015	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	51.05	1.615	0.023	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	52.02	0.830	0.016	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	52.76	0.303	0.013	0.0	0.0	0.0

Table 23 (continued)

DEUTERON FROM A = 56 BOMBARDED BY 51 MEV. PROTONS.

45 DEG - RUN 1126				52 DEG - RUN 3011				65 DEG - RUN 1133				75 DEG - RUN 3007				95 DEG - RUN 1134			
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	
11.98	0.202	0.058		5.06	0.357	0.009		11.98	0.242	0.006		5.13	0.313	0.008		12.04	0.144	0.004	
12.97	0.265	0.007		5.58	0.375	0.009		12.97	0.224	0.005		5.65	0.337	0.008		13.04	0.129	0.004	
13.97	0.274	0.007		6.10	0.426	0.009		13.96	0.199	0.005		6.18	0.349	0.008		14.03	0.123	0.004	
14.96	0.266	0.007		6.62	0.437	0.010		14.95	0.202	0.005		6.70	0.325	0.008		15.03	0.117	0.004	
15.95	0.264	0.007		7.38	0.436	0.007		15.94	0.191	0.005		7.45	0.319	0.006		16.02	0.102	0.003	
16.94	0.262	0.007		8.35	0.411	0.007		16.93	0.194	0.005		8.43	0.285	0.005		17.01	0.101	0.003	
17.93	0.250	0.007		9.33	0.380	0.007		17.93	0.176	0.005		9.41	0.251	0.005		18.01	0.085	0.003	
18.92	0.245	0.007		10.31	0.366	0.006		18.92	0.188	0.005		10.39	0.232	0.005		19.00	0.084	0.003	
19.92	0.239	0.007		11.29	0.364	0.006		19.91	0.181	0.005		11.37	0.243	0.005		19.99	0.082	0.003	
20.91	0.237	0.007		12.27	0.230	0.005		20.90	0.179	0.005		12.35	0.143	0.004		20.99	0.078	0.003	
21.90	0.261	0.007		13.25	0.242	0.005		21.89	0.157	0.005		13.33	0.143	0.004		21.98	0.073	0.003	
22.90	0.242	0.007		14.23	0.221	0.005		22.89	0.175	0.005		14.31	0.127	0.004		22.97	0.065	0.003	
23.89	0.245	0.007		15.21	0.213	0.005		23.88	0.158	0.005		15.29	0.122	0.003		23.97	0.063	0.003	
24.88	0.241	0.007		16.19	0.219	0.005		24.87	0.156	0.005		16.27	0.125	0.003		24.96	0.060	0.003	
25.87	0.240	0.007		17.17	0.216	0.005		25.86	0.155	0.005		17.25	0.114	0.003		25.95	0.054	0.003	
26.86	0.245	0.007		18.15	0.220	0.005		26.85	0.158	0.005		18.23	0.107	0.003		26.95	0.053	0.002	
27.86	0.225	0.006		19.12	0.210	0.005		27.84	0.143	0.004		19.21	0.112	0.003		27.94	0.049	0.002	
28.85	0.231	0.007		20.10	0.212	0.005		28.84	0.148	0.004		20.19	0.104	0.003		28.93	0.050	0.002	
29.84	0.215	0.006		21.08	0.208	0.005		29.83	0.142	0.004		21.17	0.104	0.003		29.93	0.044	0.002	
30.83	0.222	0.006		22.06	0.211	0.005		30.82	0.138	0.004		22.15	0.099	0.003		30.92	0.045	0.002	
31.82	0.218	0.006		23.04	0.205	0.005		31.81	0.145	0.004		23.13	0.092	0.003		31.91	0.044	0.002	
32.82	0.211	0.006		24.02	0.198	0.005		32.80	0.131	0.004		24.11	0.088	0.003		32.91	0.036	0.002	
33.81	0.209	0.006		25.00	0.205	0.005		33.80	0.122	0.004		25.19	0.090	0.003		33.99	0.035	0.002	
34.80	0.194	0.006		25.98	0.200	0.005		34.79	0.123	0.004		26.07	0.085	0.003		34.89	0.034	0.002	
35.79	0.212	0.006		26.96	0.201	0.005		35.78	0.123	0.004		27.05	0.083	0.003		35.89	0.032	0.002	
36.79	0.189	0.006		27.94	0.195	0.005		36.77	0.121	0.004		28.04	0.079	0.003		36.88	0.028	0.002	
37.78	0.198	0.006		28.91	0.203	0.005		37.76	0.116	0.004		29.02	0.076	0.003		37.87	0.024	0.002	
38.77	0.186	0.006		29.89	0.187	0.005		38.75	0.108	0.004		30.00	0.078	0.003		38.87	0.029	0.002	
39.76	0.219	0.006		30.87	0.189	0.005		39.75	0.133	0.004		30.98	0.070	0.003		39.86	0.024	0.002	
40.75	0.222	0.006		31.85	0.186	0.005		40.74	0.135	0.004		31.96	0.072	0.003		40.85	0.037	0.002	
41.75	0.197	0.006		32.83	0.176	0.004		41.73	0.125	0.004		32.94	0.071	0.003		41.85	0.017	0.001	
42.74	0.283	0.007		33.81	0.172	0.004		42.72	0.129	0.004		33.92	0.062	0.002		42.84	0.026	0.002	
43.73	0.159	0.005		34.79	0.176	0.004		43.71	0.135	0.004		34.90	0.062	0.002		43.83	0.019	0.001	
44.72	0.215	0.006		35.77	0.177	0.004		44.71	0.115	0.004		35.88	0.058	0.002		44.83	0.011	0.001	
45.72	0.255	0.007		36.75	0.163	0.004		45.70	0.087	0.003		36.86	0.055	0.002		45.82	0.023	0.002	
46.71	0.116	0.005		37.73	0.160	0.004		46.69	0.121	0.004		37.84	0.053	0.002		46.81	0.037	0.002	
47.70	0.198	0.006		38.71	0.164	0.004		47.68	0.063	0.003		38.82	0.048	0.002		47.81	0.013	0.001	
48.69	0.391	0.009		39.68	0.164	0.004		48.67	0.256	0.006		39.80	0.058	0.002		48.78	0.004	0.001	
49.68	0.302	0.007		40.66	0.190	0.005		49.66	0.255	0.006		40.78	0.046	0.002		49.78	0.000	0.000	
50.68	0.105	0.004		41.64	0.161	0.004		50.66	0.017	0.002		41.76	0.043	0.002		50.78	0.000	0.000	
51.67	0.000	0.000		42.62	0.161	0.004		51.64	0.000	0.000		42.74	0.063	0.002		51.76	0.000	0.000	
52.66	0.000	0.000		43.60	0.228	0.005		52.60	0.000	0.000		43.72	0.043	0.002		52.74	0.000	0.000	
53.65	0.000	0.000		44.58	0.143	0.004		53.60	0.000	0.000		44.70	0.045	0.002		53.72	0.000	0.000	
54.64	0.000	0.000		45.56	0.169	0.004		45.56	0.000	0.000		45.68	0.039	0.002		54.68	0.000	0.000	
55.63	0.000	0.000		46.54	0.157	0.004		46.54	0.000	0.000		46.66	0.035	0.002		55.66	0.000	0.000	
56.62	0.000	0.000		47.52	0.115	0.004		47.52	0.000	0.000		47.64	0.053	0.002		56.64	0.000	0.000	
57.61	0.000	0.000		48.50	0.209	0.005		48.50	0.000	0.000		48.62	0.089	0.003		57.62	0.000	0.000	
58.60	0.000	0.000		49.47	0.355	0.006		49.47	0.000	0.000		49.60	0.019	0.001		58.60	0.000	0.000	
59.59	0.000	0.000		50.45	0.131	0.004		50.45	0.000	0.000		50.58	0.009	0.001		59.58	0.000	0.000	
60.58	0.000	0.000		51.43	0.041	0.002		51.43	0.000	0.000		51.56	0.001	0.000		60.56	0.000	0.000	
61.57	0.000	0.000		52.41	0.003	0.001		52.41	0.000	0.000		52.54	0.000	0.000		61.54	0.000	0.000	
62.56	0.000	0.000		53.40	0.003	0.002		53.40	0.000	0.000		53.54	0.000	0.000		62.54	0.000	0.000	
63.55	0.000	0.000		54.39	0.003	0.002		54.39	0.000	0.000		54.54	0.000	0.000		63.54	0.000	0.000	
64.54	0.000	0.000		55.38	0.003	0.002		55.38	0.000	0.000		55.54	0.000	0.000		64.54	0.000	0.000	
65.53	0.000	0.000		56.37	0.003	0.002		56.37	0.000	0.000		56.54	0.000	0.000		65.54	0.000	0.000	
66.52	0.000	0.000		57.36	0.003	0.002		57.36	0.000	0.000		57.54	0.000	0.000		66.54	0.000	0.000	
67.51	0.000	0.000		58.35	0.003	0.002		58.35	0.000	0.000		58.54	0.000	0.000		67.54	0.000	0.000	
68.50	0.000	0.000		59.34															



Table 23 (continued)

DEUTERON FROM A = 56 BOMBARDED BY 51 MEV. PROTONS.									
120 DEG - RUN 1140.					135 DEG - RUN 4013				
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)
12.00	0.102	0.002	4.97	0.277	0.008	4.97	0.277	0.008	4.97
12.99	0.082	0.002	5.37	0.282	0.008	5.37	0.282	0.008	5.37
13.99	0.07	0.002	5.77	0.269	0.008	5.77	0.269	0.008	5.77
14.98	0.061	0.002	6.17	0.265	0.008	6.17	0.265	0.008	6.17
15.98	0.058	0.002	6.57	0.254	0.008	6.57	0.254	0.008	6.57
16.97	0.50	0.002	7.26	0.226	0.005	7.26	0.226	0.005	7.26
17.96	0.045	0.001	8.26	0.190	0.004	8.26	0.190	0.004	8.26
18.96	0.041	0.001	9.26	0.159	0.004	9.26	0.159	0.004	9.26
19.95	0.038	0.001	10.26	0.131	0.004	10.26	0.131	0.004	10.26
20.94	0.032	0.001	11.26	0.123	0.003	11.26	0.123	0.003	11.26
21.94	0.031	0.001	12.26	0.080	0.003	12.26	0.080	0.003	12.26
22.93	0.027	0.001	13.26	0.055	0.002	13.26	0.055	0.002	13.26
23.93	0.026	0.001	14.26	0.050	0.002	14.26	0.050	0.002	14.26
24.92	0.023	0.001	15.25	0.048	0.002	15.25	0.048	0.002	15.25
25.91	0.020	0.001	16.25	0.043	0.002	16.25	0.043	0.002	16.25
26.91	0.017	0.001	17.25	0.032	0.002	17.25	0.032	0.002	17.25
27.90	0.017	0.001	18.25	0.030	0.002	18.25	0.030	0.002	18.25
28.89	0.015	0.001	19.25	0.027	0.002	19.25	0.027	0.002	19.25
29.89	0.013	0.001	20.25	0.024	0.002	20.25	0.024	0.002	20.25
30.88	0.013	0.001	21.25	0.021	0.001	21.25	0.021	0.001	21.25
31.88	0.009	0.001	22.24	0.021	0.001	22.24	0.021	0.001	22.24
32.87	0.008	0.001	23.24	0.016	0.001	23.24	0.016	0.001	23.24
33.86	0.009	0.001	24.24	0.015	0.001	24.24	0.015	0.001	24.24
34.86	0.007	0.001	25.24	0.013	0.001	25.24	0.013	0.001	25.24
35.85	0.006	0.001	26.24	0.011	0.001	26.24	0.011	0.001	26.24
36.85	0.006	0.001	27.24	0.008	0.001	27.24	0.008	0.001	27.24
37.84	0.005	0.000	28.24	0.009	0.001	28.24	0.009	0.001	28.24
38.83	0.005	0.000	29.23	0.008	0.001	29.23	0.008	0.001	29.23
39.83	0.007	0.001	30.23	0.005	0.001	30.23	0.005	0.001	30.23
40.82	0.004	0.000	31.23	0.006	0.001	31.23	0.006	0.001	31.23
41.81	0.005	0.000	32.23	0.006	0.001	32.23	0.006	0.001	32.23
42.81	0.003	0.000	33.23	0.004	0.001	33.23	0.004	0.001	33.23
43.80	0.002	0.000	34.23	0.005	0.001	34.23	0.005	0.001	34.23
44.80	0.004	0.000	35.23	0.003	0.001	35.23	0.003	0.001	35.23
45.79	0.006	0.001	36.22	0.002	0.000	36.22	0.002	0.000	36.22
46.78	0.001	0.000	37.22	0.002	0.001	37.22	0.002	0.001	37.22
47.61	0.00	0.000	38.22	0.002	0.000	38.22	0.002	0.000	38.22
0.0	0.0	0.0	39.22	0.002	0.000	39.22	0.002	0.000	39.22
0.0	0.0	0.0	40.22	0.002	0.000	40.22	0.002	0.000	40.22
0.0	0.0	0.0	41.22	0.002	0.000	41.22	0.002	0.000	41.22
0.0	0.0	0.0	42.22	0.001	0.000	42.22	0.001	0.000	42.22
0.0	0.0	0.0	43.21	0.001	0.000	43.21	0.001	0.000	43.21
0.0	0.0	0.0	44.21	0.002	0.000	44.21	0.002	0.000	44.21
0.0	0.0	0.0	45.21	0.001	0.000	45.21	0.001	0.000	45.21
0.0	0.0	0.0	46.21	0.001	0.000	46.21	0.001	0.000	46.21
0.0	0.0	0.0	47.21	0.001	0.000	47.21	0.001	0.000	47.21
0.0	0.0	0.0	48.03	0.00	0.0	48.03	0.00	0.0	48.03



Table 23 (continued)

TRITON FROM A = 56 BOMBARDED BY 51 MEV. PROTONS.

15 DEG - RUN 1131				22 DEG - RUN 2012				20 DEG - RUN 1133				30 DEG - RUN 1127				37 DEG - RUN 3010			
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	
13.90	0.116	0.016		6.12	0.257	0.012		13.90	0.034	0.002		13.91	0.077	0.005		6.17	0.061	0.005	
14.89	0.079	0.013		6.64	0.246	0.012		14.89	0.013	0.003		14.92	0.068	0.004		6.69	0.074	0.006	
15.88	0.083	0.013		7.38	0.282	0.009		15.88	0.026	0.004		15.90	0.072	0.005		7.44	0.073	0.004	
16.87	0.087	0.014		8.36	0.289	0.010		16.88	0.053	0.006		16.88	0.066	0.004		8.42	0.076	0.004	
17.86	0.076	0.013		9.33	0.260	0.009		17.87	0.072	0.005		17.88	0.064	0.004		9.40	0.074	0.004	
18.85	0.099	0.015		10.30	0.259	0.009		18.85	0.055	0.006		18.87	0.067	0.004		10.38	0.069	0.004	
19.84	0.105	0.015		11.27	0.210	0.010		19.85	0.052	0.006		19.86	0.061	0.004		11.36	0.068	0.004	
20.83	0.088	0.014		12.24	0.196	0.008		20.84	0.074	0.006		20.86	0.063	0.004		12.34	0.068	0.004	
21.82	0.086	0.014		13.22	0.133	0.006		21.83	0.056	0.006		21.85	0.069	0.004		13.32	0.070	0.004	
22.81	0.093	0.014		14.19	0.098	0.006		22.82	0.086	0.007		22.84	0.064	0.004		14.30	0.046	0.003	
23.80	0.106	0.015		15.16	0.091	0.005		23.81	0.084	0.007		23.83	0.074	0.005		15.28	0.052	0.003	
24.79	0.152	0.011		16.13	0.073	0.005		24.80	0.077	0.006		24.82	0.068	0.004		16.25	0.043	0.003	
25.78	0.094	0.014		17.10	0.071	0.005		25.80	0.085	0.007		25.82	0.063	0.004		17.23	0.048	0.003	
26.77	0.118	0.016		18.07	0.071	0.005		26.79	0.071	0.006		26.81	0.071	0.005		18.21	0.043	0.003	
27.76	0.115	0.015		19.05	0.073	0.005		27.78	0.091	0.007		27.80	0.071	0.005		19.19	0.043	0.003	
28.75	0.108	0.015		20.02	0.080	0.005		28.77	0.078	0.006		28.79	0.057	0.004		20.17	0.044	0.003	
29.74	0.105	0.015		20.99	0.072	0.005		29.76	0.085	0.007		29.78	0.062	0.004		21.15	0.044	0.003	
30.73	0.076	0.013		21.96	0.081	0.005		30.75	0.079	0.006		30.77	0.051	0.004		22.13	0.045	0.003	
31.72	0.096	0.014		22.93	0.071	0.005		31.74	0.098	0.007		31.77	0.063	0.004		23.11	0.045	0.003	
32.71	0.135	0.017		23.90	0.067	0.005		32.73	0.103	0.007		32.76	0.063	0.004		24.09	0.041	0.003	
33.70	0.146	0.018		24.88	0.072	0.005		33.73	0.087	0.007		33.75	0.060	0.004		25.07	0.041	0.003	
34.69	0.134	0.017		25.85	0.079	0.005		34.72	0.094	0.007		34.74	0.060	0.004		26.05	0.047	0.003	
35.68	0.124	0.017		26.82	0.070	0.005		35.71	0.101	0.007		35.74	0.067	0.004		27.03	0.044	0.003	
36.67	0.129	0.017		27.79	0.076	0.005		36.70	0.113	0.008		36.73	0.060	0.004		28.01	0.046	0.003	
37.66	0.100	0.015		28.76	0.091	0.005		37.69	0.105	0.007		37.72	0.055	0.004		28.98	0.043	0.003	
38.65	0.119	0.016		29.73	0.077	0.005		38.68	0.098	0.007		38.71	0.052	0.004		29.96	0.045	0.003	
39.64	0.140	0.018		30.71	0.082	0.005		39.67	0.075	0.006		39.70	0.050	0.004		30.94	0.040	0.003	
40.63	0.120	0.017		31.68	0.082	0.005		40.66	0.110	0.008		40.70	0.059	0.004		31.92	0.042	0.003	
41.62	0.139	0.017		32.65	0.088	0.005		41.66	0.079	0.007		41.69	0.026	0.003		32.90	0.045	0.003	
42.61	0.189	0.014		33.62	0.080	0.005		42.65	0.050	0.005		42.68	0.032	0.003		33.88	0.037	0.003	
43.60	0.164	0.012		34.59	0.096	0.006		43.64	0.059	0.006		43.67	0.031	0.003		34.86	0.043	0.003	
44.59	0.109	0.010		35.56	0.121	0.006		44.63	0.091	0.007		44.66	0.049	0.004		35.84	0.048	0.003	
45.58	0.047	0.010		36.54	0.128	0.006		45.52	0.051	0.006		45.56	0.005	0.001		36.82	0.042	0.003	
46.57	0.052	0.011		37.51	0.132	0.006		46.51	0.030	0.004		46.55	0.010	0.002		37.80	0.039	0.003	
47.56	0.082	0.013		38.48	0.152	0.007		47.50	0.128	0.008		47.54	0.013	0.002		38.78	0.037	0.003	
48.55	0.056	0.016		39.45	0.152	0.007		48.37	0.037	0.007		48.21	0.005	0.003		39.76	0.029	0.003	
49.54	0.000	0.000		40.42	0.138	0.007		49.37	0.000	0.000		49.21	0.000	0.000		40.73	0.033	0.003	
50.53	0.000	0.000		41.39	0.178	0.007		50.37	0.000	0.000		50.21	0.000	0.000		41.71	0.032	0.003	
51.52	0.000	0.000		42.37	0.258	0.009		51.37	0.000	0.000		51.21	0.000	0.000		42.69	0.020	0.002	
52.51	0.000	0.000		43.34	0.156	0.007		52.37	0.000	0.000		52.21	0.000	0.000		43.67	0.020	0.002	
53.50	0.000	0.000		44.31	0.239	0.009		53.37	0.000	0.000		53.21	0.000	0.000		44.65	0.023	0.002	
54.49	0.000	0.000		45.28	0.182	0.008		54.37	0.000	0.000		54.21	0.000	0.000		45.63	0.011	0.002	
55.48	0.000	0.000		46.25	0.219	0.008		55.37	0.000	0.000		55.21	0.000	0.000		46.61	0.007	0.001	
56.47	0.000	0.000		47.22	0.307	0.010		56.37	0.000	0.000		56.21	0.000	0.000		47.59	0.008	0.001	
57.46	0.000	0.000		48.20	0.301	0.010		57.37	0.000	0.000		57.21	0.000	0.000		48.57	0.013	0.002	
58.45	0.000	0.000		49.17	0.391	0.011		58.37	0.000	0.000		58.21	0.000	0.000		49.55	0.003	0.001	
59.44	0.000	0.000		50.14	0.183	0.012		59.37	0.000	0.000		59.21	0.000	0.000		0.00	0.000	0.000	

Table 24

TRITON FROM A = 75 BOMBARDED BY 51 MEV. PROTONS.

45 DEG - RUN 1126			52 DEG - RUN 3011			60 DEG - RUN 1133			75 DEG - RUN 3007			92 DEG - RUN 1134		
ENERGY (MEV)	SIGMA (MB/SR-NEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-NEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-NEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-NEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-NEV)	ERROR
13.92	0.060	0.003	6.17	0.069	0.004	13.91	0.043	0.002	6.18	0.048	0.002	13.98	0.019	0.002
14.91	0.057	0.003	6.69	0.072	0.004	14.97	0.038	0.002	6.71	0.052	0.003	14.98	0.015	0.001
15.90	0.049	0.003	7.44	0.072	0.003	15.89	0.036	0.002	7.45	0.050	0.002	15.97	0.016	0.001
16.89	0.052	0.003	8.42	0.075	0.003	16.89	0.033	0.002	8.43	0.052	0.002	16.96	0.016	0.001
17.88	0.045	0.003	9.47	0.077	0.003	17.88	0.032	0.002	9.41	0.048	0.002	17.96	0.015	0.001
18.98	0.048	0.003	10.38	0.071	0.003	18.87	0.028	0.002	10.39	0.050	0.002	18.95	0.011	0.001
19.87	0.044	0.003	11.35	0.066	0.003	19.86	0.028	0.002	11.37	0.035	0.002	19.94	0.012	0.001
20.86	0.043	0.003	12.34	0.061	0.003	20.85	0.028	0.002	12.35	0.033	0.002	20.94	0.009	0.001
21.85	0.047	0.003	13.32	0.068	0.003	21.85	0.030	0.002	13.33	0.033	0.002	21.93	0.010	0.001
22.85	0.047	0.003	14.29	0.039	0.002	22.84	0.024	0.002	14.31	0.022	0.001	22.92	0.008	0.001
23.84	0.044	0.003	15.27	0.042	0.002	23.83	0.029	0.002	15.29	0.021	0.001	23.92	0.007	0.001
24.83	0.040	0.003	16.25	0.033	0.002	24.82	0.025	0.002	16.27	0.019	0.001	24.91	0.008	0.001
25.82	0.040	0.003	17.23	0.035	0.002	25.81	0.025	0.002	17.25	0.017	0.001	25.90	0.007	0.001
26.81	0.042	0.003	18.21	0.038	0.002	26.80	0.024	0.002	18.23	0.015	0.001	26.90	0.006	0.001
27.81	0.035	0.003	19.19	0.035	0.002	27.80	0.023	0.002	19.21	0.017	0.001	27.89	0.006	0.001
28.80	0.037	0.003	20.17	0.036	0.002	28.79	0.021	0.002	20.19	0.014	0.001	28.88	0.007	0.001
29.79	0.035	0.003	21.15	0.033	0.002	29.78	0.023	0.002	21.17	0.013	0.001	29.88	0.005	0.001
30.78	0.034	0.003	22.13	0.033	0.002	30.77	0.019	0.002	22.15	0.014	0.001	30.87	0.005	0.001
31.78	0.036	0.003	23.11	0.034	0.002	31.76	0.016	0.001	23.13	0.013	0.001	31.86	0.004	0.001
32.77	0.033	0.002	24.08	0.031	0.002	32.75	0.015	0.001	24.11	0.011	0.001	32.86	0.004	0.001
33.76	0.031	0.002	25.06	0.029	0.002	33.75	0.015	0.002	25.09	0.012	0.001	33.85	0.004	0.001
34.75	0.036	0.003	26.04	0.034	0.002	34.74	0.017	0.002	26.07	0.012	0.001	34.84	0.003	0.001
35.74	0.033	0.002	27.02	0.031	0.002	35.73	0.013	0.001	27.05	0.012	0.001	35.84	0.003	0.001
36.74	0.031	0.002	28.00	0.027	0.002	36.72	0.014	0.001	28.04	0.011	0.001	36.83	0.002	0.001
37.73	0.026	0.002	28.98	0.026	0.002	37.71	0.013	0.001	29.02	0.010	0.001	37.82	0.003	0.001
38.72	0.021	0.002	29.96	0.031	0.002	38.70	0.012	0.001	30.00	0.009	0.001	38.82	0.001	0.000
39.71	0.026	0.002	30.94	0.028	0.002	39.70	0.010	0.001	30.98	0.009	0.001	39.81	0.001	0.000
40.71	0.019	0.002	31.92	0.029	0.002	40.69	0.008	0.001	31.96	0.009	0.001	40.80	0.000	0.000
41.70	0.019	0.002	32.90	0.026	0.002	41.68	0.006	0.001	32.94	0.008	0.001	41.80	0.001	0.000
42.69	0.019	0.001	33.88	0.027	0.002	42.67	0.006	0.001	33.92	0.010	0.001	42.79	0.000	0.000
43.68	0.014	0.002	34.85	0.029	0.002	43.66	0.006	0.001	34.93	0.007	0.001	43.78	0.000	0.000
44.67	0.016	0.001	35.83	0.022	0.002	44.66	0.003	0.001	35.88	0.006	0.001	44.78	0.000	0.000
45.67	0.017	0.001	36.81	0.022	0.002	45.65	0.003	0.001	36.86	0.005	0.001	45.67	0.000	0.000
46.66	0.013	0.002	37.79	0.020	0.002	46.59	0.008	0.001	37.84	0.004	0.001	46.66	0.000	0.000
47.65	0.007	0.001	38.77	0.018	0.001	0.00	0.00	0.00	38.82	0.005	0.001	47.65	0.000	0.000
0.00	0.00	0.00	39.75	0.022	0.002	0.00	0.00	0.00	39.80	0.005	0.001	0.00	0.00	0.00
0.00	0.00	0.00	40.73	0.020	0.001	0.00	0.00	0.00	40.78	0.003	0.001	0.00	0.00	0.00
0.00	0.00	0.00	41.71	0.014	0.001	0.00	0.00	0.00	41.76	0.004	0.001	0.00	0.00	0.00
0.00	0.00	0.00	42.69	0.013	0.001	0.00	0.00	0.00	42.74	0.003	0.001	0.00	0.00	0.00
0.00	0.00	0.00	43.67	0.009	0.001	0.00	0.00	0.00	43.72	0.002	0.000	0.00	0.00	0.00
0.00	0.00	0.00	44.64	0.010	0.001	0.00	0.00	0.00	44.70	0.001	0.000	0.00	0.00	0.00
0.00	0.00	0.00	45.62	0.004	0.001	0.00	0.00	0.00	45.68	0.001	0.000	0.00	0.00	0.00
0.00	0.00	0.00	46.60	0.004	0.001	0.00	0.00	0.00	46.66	0.001	0.000	0.00	0.00	0.00
0.00	0.00	0.00	47.58	0.005	0.001	0.00	0.00	0.00	47.64	0.001	0.000	0.00	0.00	0.00
0.00	0.00	0.00	48.56	0.002	0.001	0.00	0.00	0.00	48.62	0.000	0.000	0.00	0.00	0.00
0.00	0.00	0.00	49.54	0.003	0.001	0.00	0.00	0.00	49.57	0.001	0.000	0.00	0.00	0.00

Table 24 (continued)

TRITON FROM A = 56 BOMBARDED BY 51 MEV. PROTONS.

120 DEG - RUN 1140				135 DEG - RUN 4013			
ENERGY (MEV)	SIGMA (MB/SR-MEV)	SIGMA ERROR (MB/SR-MEV)	ENERGY (MEV)	ENERGY (MEV)	SIGMA ERROR (MB/SR-MEV)	ENERGY (MEV)	SIGMA ERROR (MB/SR-MEV)
13.94	0.011	0.001	5.62	0.048	0.003	10.11	0.022
14.93	0.009	0.001	6.62	0.041	0.003	11.11	0.020
15.93	0.016	0.001	7.42	0.035	0.003	12.11	0.016
16.92	0.006	0.001	8.11	0.031	0.002	13.11	0.013
17.91	0.005	0.000	9.11	0.027	0.002	14.11	0.009
18.91	0.005	0.000	10.11	0.022	0.001	15.11	0.005
19.90	0.005	0.000	11.11	0.020	0.001	16.10	0.004
20.89	0.005	0.000	12.11	0.016	0.001	17.10	0.004
21.89	0.003	0.000	13.11	0.013	0.001	18.10	0.002
22.88	0.003	0.000	14.11	0.009	0.001	19.10	0.002
23.88	0.003	0.000	15.11	0.005	0.001	20.10	0.002
24.87	0.003	0.000	16.10	0.004	0.001	21.10	0.001
25.86	0.001	0.000	17.10	0.004	0.001	22.09	0.002
26.86	0.001	0.000	18.10	0.002	0.000	23.09	0.001
27.85	0.002	0.000	19.10	0.002	0.001	24.09	0.001
28.85	0.002	0.000	20.10	0.002	0.000	25.09	0.001
29.84	0.001	0.000	21.10	0.001	0.000	26.09	0.001
30.83	0.001	0.000	22.09	0.001	0.000	27.09	0.001
31.83	0.001	0.000	23.09	0.001	0.000	28.09	0.001
32.82	0.001	0.000	24.09	0.001	0.000	29.08	0.000
33.81	0.001	0.000	25.09	0.001	0.000	30.08	0.000
34.81	0.001	0.000	26.09	0.001	0.000	31.08	0.000
35.80	0.000	0.000	27.09	0.001	0.000	32.08	0.000
36.80	0.000	0.000	28.09	0.001	0.000	33.08	0.000
37.79	0.000	0.000	29.08	0.000	0.000	34.08	0.000
38.78	0.000	0.000	30.08	0.000	0.000	35.08	0.000
39.78	0.000	0.000	31.08	0.000	0.000	36.07	0.000
40.77	0.000	0.000	32.08	0.000	0.000	37.07	0.000
41.76	0.000	0.000	33.08	0.000	0.000	38.07	0.000
42.76	0.000	0.000	34.08	0.000	0.000	39.07	0.000
43.67	0.000	0.000	35.08	0.000	0.000	40.07	0.000
0.0	0.0	0.0	36.07	0.000	0.000	41.07	0.000
0.0	0.0	0.0	37.07	0.000	0.000	42.07	0.000
0.0	0.0	0.0	38.07	0.000	0.000	43.06	0.000
0.0	0.0	0.0	39.07	0.000	0.000	43.89	0.000
0.0	0.0	0.0	40.07	0.000	0.000		
0.0	0.0	0.0	41.07	0.000	0.000		
0.0	0.0	0.0	42.07	0.000	0.000		
0.0	0.0	0.0	43.06	0.000	0.000		
0.0	0.0	0.0	43.89	0.000	0.000		

Table 25

HELIUM-3 FROM A = 56 BOMBARDED BY 62 MEV. PROTONS.

27 DEG - RUN 3012			37 DEG - RUN 3010			52 DEG - RUN 3011			75 DEG - RUN 3007			135 DEG - RUN 4013		
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR
13.28	0.003	0.001	13.38	0.033	0.002	13.38	0.033	0.002	13.46	0.022	0.001	12.76	0.012	0.001
14.25	0.003	0.001	14.36	0.040	0.003	14.36	0.040	0.002	14.44	0.023	0.002	13.76	0.010	0.001
15.22	0.007	0.001	15.34	0.042	0.003	15.34	0.038	0.002	15.42	0.020	0.001	14.75	0.011	0.001
16.19	0.008	0.002	16.32	0.034	0.003	16.32	0.036	0.002	16.40	0.018	0.001	15.75	0.008	0.001
17.17	0.017	0.002	17.37	0.037	0.003	17.30	0.034	0.002	17.38	0.016	0.001	16.75	0.007	0.001
18.14	0.010	0.002	18.28	0.040	0.003	18.28	0.030	0.002	18.36	0.018	0.001	17.75	0.006	0.001
19.11	0.016	0.002	19.26	0.032	0.003	19.25	0.032	0.002	19.34	0.017	0.001	18.75	0.006	0.001
20.08	0.015	0.002	20.24	0.037	0.003	20.23	0.032	0.002	20.32	0.016	0.001	19.75	0.005	0.001
21.05	0.014	0.002	21.22	0.036	0.003	21.21	0.028	0.002	21.30	0.015	0.001	20.75	0.003	0.001
22.03	0.019	0.002	22.20	0.036	0.003	22.19	0.029	0.002	22.28	0.013	0.001	21.74	0.004	0.001
23.01	0.021	0.003	23.17	0.038	0.003	23.17	0.027	0.002	23.26	0.012	0.001	22.74	0.003	0.001
24.04	0.027	0.003	24.15	0.037	0.003	24.15	0.029	0.002	24.24	0.010	0.001	23.74	0.002	0.000
25.01	0.021	0.003	25.13	0.033	0.003	25.13	0.028	0.002	25.23	0.010	0.001	24.74	0.001	0.000
26.08	0.021	0.003	26.11	0.043	0.003	26.11	0.023	0.002	26.21	0.010	0.001	25.74	0.002	0.000
27.06	0.021	0.003	27.09	0.036	0.003	27.09	0.027	0.002	27.19	0.010	0.001	26.74	0.001	0.000
28.03	0.022	0.003	28.07	0.037	0.003	28.07	0.027	0.002	28.17	0.010	0.001	27.74	0.002	0.000
29.03	0.024	0.004	29.05	0.041	0.003	29.05	0.026	0.002	29.15	0.010	0.001	28.73	0.001	0.000
30.03	0.024	0.002	30.03	0.042	0.003	30.02	0.025	0.002	30.13	0.008	0.001	29.73	0.001	0.000
31.01	0.010	0.002	31.01	0.035	0.003	31.00	0.028	0.002	31.11	0.007	0.001	30.73	0.001	0.000
32.01	0.018	0.005	32.01	0.024	0.002	31.98	0.018	0.001	32.09	0.007	0.001	31.73	0.000	0.000
33.01	0.018	0.005	32.97	0.044	0.003	32.96	0.027	0.002	33.07	0.008	0.001	32.73	0.000	0.000
34.01	0.059	0.004	33.95	0.037	0.003	33.94	0.021	0.002	34.05	0.007	0.001	33.73	0.000	0.000
35.01	0.062	0.004	34.92	0.025	0.002	34.92	0.019	0.001	35.03	0.004	0.001	34.73	0.000	0.000
36.01	0.049	0.004	35.91	0.036	0.003	35.90	0.016	0.001	36.01	0.004	0.001	35.72	0.000	0.000
37.01	0.060	0.004	36.88	0.026	0.002	36.88	0.014	0.001	36.99	0.004	0.001	36.72	0.000	0.000
38.01	0.079	0.005	37.86	0.024	0.002	37.86	0.011	0.001	37.97	0.003	0.001	37.72	0.000	0.000
39.01	0.077	0.005	38.84	0.023	0.002	38.84	0.012	0.001	38.95	0.003	0.001	38.72	0.000	0.000
40.01	0.039	0.004	39.82	0.023	0.002	39.81	0.011	0.001	39.93	0.002	0.001	39.72	0.000	0.000
41.01	0.101	0.006	40.80	0.023	0.002	40.79	0.010	0.001	40.91	0.002	0.001	40.72	0.000	0.000
42.01	0.072	0.005	41.78	0.038	0.003	41.77	0.013	0.001	41.89	0.002	0.000	41.72	0.000	0.000
43.01	0.074	0.005	42.76	0.027	0.002	42.75	0.010	0.001	42.87	0.001	0.000	42.72	0.000	0.000
44.01	0.070	0.005	43.74	0.020	0.002	43.73	0.007	0.001	43.85	0.000	0.000	43.39	0.000	0.000
45.01	0.038	0.003	44.72	0.016	0.002	44.71	0.003	0.001	44.83	0.000	0.000	0.0	0.0	0.0
46.01	0.030	0.003	45.70	0.010	0.002	45.69	0.002	0.000	45.81	0.000	0.000	0.0	0.0	0.0
47.01	0.007	0.001	46.68	0.003	0.001	46.67	0.001	0.000	46.79	0.000	0.000	0.0	0.0	0.0
48.01	0.000	0.000	47.65	0.001	0.000	47.65	0.001	0.000	47.77	0.000	0.000	0.0	0.0	0.0
49.01	0.000	0.000	48.63	0.001	0.000	48.63	0.000	0.000	48.75	0.000	0.000	0.0	0.0	0.0
50.01	0.000	0.000	49.58	0.001	0.000	49.57	0.000	0.000	49.63	0.000	0.000	0.0	0.0	0.0
51.01	0.000	0.000	50.58	0.000	0.000	50.57	0.000	0.000	50.63	0.000	0.000	0.0	0.0	0.0
52.01	0.000	0.000	51.58	0.000	0.000	51.57	0.000	0.000	51.63	0.000	0.000	0.0	0.0	0.0

Table 26

ALPHA FROM A = 56 BOMBARDED BY 52 MEV. PROTONS.

22 DEG - RUN 2012				37 DEG - RUN 3010				52 DEG - RUN 3011				75 DEG - RUN 3007				135 DEG - RUN 4013			
ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR		ENERGY (MEV)	SIGMA (MB/SR-MEV)	ERROR	
14.64	0.622	0.014		14.75	0.630	0.012		14.75	0.572	0.038		14.83	0.351	0.006		14.30	0.204	0.004	
15.61	0.433	0.012		15.73	0.510	0.011		15.73	0.456	0.037		15.81	0.265	0.005		15.30	0.149	0.004	
16.53	0.356	0.011		16.71	0.404	0.010		16.71	0.377	0.006		16.79	0.204	0.004		16.30	0.105	0.003	
17.56	0.301	0.010		17.69	0.348	0.009		17.69	0.311	0.006		17.78	0.155	0.004		17.30	0.075	0.003	
18.53	0.264	0.009		18.67	0.300	0.008		18.67	0.253	0.005		18.76	0.131	0.004		18.30	0.069	0.002	
19.57	0.257	0.009		19.65	0.249	0.007		19.65	0.217	0.005		19.74	0.110	0.003		19.30	0.044	0.002	
20.47	0.225	0.008		20.63	0.231	0.007		20.63	0.198	0.005		20.72	0.098	0.003		20.30	0.030	0.002	
21.44	0.232	0.009		21.61	0.201	0.007		21.60	0.155	0.004		21.70	0.082	0.003		21.30	0.027	0.002	
22.41	0.235	0.009		22.59	0.179	0.006		22.58	0.147	0.004		22.68	0.072	0.003		22.29	0.022	0.001	
23.39	0.205	0.008		23.57	0.173	0.006		23.56	0.126	0.004		23.66	0.061	0.002		23.29	0.018	0.001	
24.36	0.225	0.008		24.55	0.164	0.006		24.54	0.121	0.004		24.64	0.053	0.002		24.29	0.015	0.001	
25.33	0.233	0.008		25.52	0.145	0.006		25.52	0.118	0.004		25.62	0.046	0.002		25.29	0.011	0.001	
26.30	0.212	0.008		26.50	0.138	0.006		26.50	0.107	0.003		26.60	0.040	0.002		26.29	0.008	0.001	
27.27	0.209	0.008		27.48	0.120	0.005		27.48	0.097	0.003		27.58	0.040	0.002		27.29	0.008	0.001	
28.24	0.244	0.008		28.46	0.111	0.005		28.46	0.090	0.003		28.56	0.035	0.002		28.29	0.007	0.001	
29.22	0.178	0.007		29.44	0.102	0.005		29.44	0.074	0.003		29.54	0.028	0.002		29.28	0.005	0.001	
30.19	0.183	0.008		30.42	0.103	0.005		30.42	0.070	0.003		30.52	0.028	0.002		30.28	0.004	0.001	
31.16	0.185	0.008		31.40	0.081	0.004		31.39	0.058	0.003		31.53	0.024	0.002		31.28	0.003	0.001	
32.13	0.141	0.007		32.38	0.080	0.004		32.37	0.050	0.003		32.48	0.023	0.002		32.28	0.003	0.001	
33.10	0.142	0.007		33.36	0.083	0.004		33.35	0.053	0.003		33.46	0.021	0.001		33.28	0.002	0.000	
34.07	0.124	0.006		34.34	0.088	0.004		34.33	0.058	0.003		34.44	0.018	0.001		34.28	0.001	0.000	
35.05	0.127	0.006		35.32	0.043	0.003		35.31	0.036	0.002		35.42	0.012	0.001		35.28	0.001	0.000	
36.02	0.057	0.004		36.30	0.014	0.002		36.29	0.007	0.001		36.40	0.005	0.001		36.27	0.001	0.000	
36.99	0.126	0.006		37.27	0.071	0.004		37.27	0.043	0.002		37.38	0.013	0.001		37.27	0.001	0.000	
37.96	0.092	0.005		38.25	0.049	0.003		38.25	0.029	0.002		38.36	0.009	0.001		38.27	0.000	0.000	
38.93	0.085	0.005		39.23	0.041	0.003		39.23	0.027	0.002		39.34	0.008	0.001		39.27	0.000	0.000	
39.90	0.068	0.005		40.21	0.043	0.003		40.21	0.024	0.002		40.32	0.007	0.001		40.27	0.000	0.000	
40.88	0.115	0.006		41.19	0.037	0.003		41.19	0.023	0.002		41.30	0.006	0.001		41.27	0.000	0.000	
41.85	0.076	0.005		42.17	0.035	0.003		42.16	0.018	0.001		42.28	0.005	0.001		42.27	0.000	0.000	
42.82	0.030	0.004		43.15	0.037	0.003		43.14	0.023	0.001		43.26	0.004	0.001		43.26	0.000	0.000	
43.79	0.053	0.004		44.13	0.029	0.003		44.12	0.019	0.001		44.24	0.004	0.001		44.26	0.000	0.000	
44.76	0.025	0.004		45.11	0.024	0.002		45.10	0.013	0.001		45.22	0.004	0.001		45.26	0.000	0.000	
45.73	0.025	0.004		46.09	0.033	0.003		46.08	0.017	0.001		46.20	0.004	0.001		46.26	0.000	0.000	
46.71	0.043	0.004		47.07	0.034	0.003		47.06	0.013	0.001		47.18	0.003	0.001		47.26	0.000	0.000	
47.68	0.038	0.003		48.05	0.019	0.002		48.04	0.010	0.001		48.16	0.002	0.000		48.26	0.000	0.000	
48.65	0.040	0.004		49.03	0.021	0.002		49.02	0.007	0.001		49.14	0.001	0.000		49.26	0.000	0.000	
49.62	0.042	0.004		50.00	0.012	0.002		50.00	0.007	0.001		50.12	0.001	0.000		50.25	0.000	0.000	
50.59	0.037	0.003		50.98	0.011	0.002		50.98	0.002	0.000		51.10	0.000	0.000		51.25	0.000	0.000	
51.56	0.030	0.003		51.96	0.006	0.001		51.95	0.002	0.000		52.08	0.000	0.000		52.25	0.000	0.000	
52.54	0.017	0.002		52.94	0.006	0.001		52.93	0.001	0.000		53.06	0.000	0.000		52.83	0.000	0.000	
53.51	0.018	0.002		53.92	0.002	0.001		53.91	0.000	0.000		54.04	0.000	0.000		0.00	0.000	0.000	
54.28	0.015	0.002		54.80	0.001	0.001		54.89	0.000	0.000		55.02	0.000	0.000		0.00	0.000	0.000	
55.45	0.015	0.001		55.88	0.001	0.001		55.87	0.001	0.001		56.00	0.000	0.000		0.00	0.000	0.000	
56.22	0.006	0.001		56.86	0.003	0.001		56.85	0.000	0.000		56.99	0.000	0.000		0.00	0.000	0.000	
57.40	0.021	0.003		57.84	0.000	0.000		57.83	0.000	0.000		57.97	0.000	0.000		0.00	0.000	0.000	
58.37	0.016	0.001		58.82	0.000	0.000		58.81	0.000	0.000		59.05	0.000	0.000		0.00	0.000	0.000	
59.34	0.000	0.000		59.67	0.000	0.000		59.66	0.000	0.000		59.73	0.000	0.000		0.00	0.000	0.000	
59.92	0.000	0.000		0.00	0.000	0.000		0.00	0.000	0.000		0.00	0.000	0.000		0.00	0.000	0.000	

References

<sup>1</sup>Details of the experimental system are described in reference A, while references A and B describe the data analysis system. References A, B, and C contain tabulated data from various targets.

- A) F. E. Bertrand et al, Differential Cross Sections for the Charged Particles Produced by 60-MeV Protons on Carbon, Iron, and Bismuth, ORNL-4274 (1968).
- B) F. E. Bertrand and R. W. Peelle, Tabulated Cross Sections for Hydrogen and Helium Particles Produced by 62-MeV Protons on <sup>89</sup>Y, ORNL-4450, (1969).
- C) F. E. Bertrand and R. W. Peele, Tabulated Cross Sections for Hydrogen and Helium Particles Produced by 62-MeV and 28-MeV Protons on <sup>27</sup>Al, ORNL-4455 (1969).

<sup>2</sup>F. E. Bertrand et al, "A Total Absorption Detector for 60-MeV Protons using Lithium-Drifted Germanium", Proceedings of Ninth Scintillation and Semi-conductor Symposium, June 1966, pg. 279.